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A proposal of new environmental friendly gases for the use in electrical insulation application, II
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As new environmental friendly gases are needed for insulation applications, the following gases are published in combination with the following commonly known features and applications.

The “***gas***” marked idioms stand for gas mixtures containing at least one of the following gases:

1) Trans-1,3,3,3-Tetrafluoroprop-1-ene, HFO-1234ze, CAS 1645-83-6
2) Trans-1-Chloro-3,3,3-trifluoroprop-1-ene, R-1233zd, CAS 102687-65-0
3) Cis-1,2,3,3,3-Pentafluoropropene, R-1225ye(Z), CAS 5528-43-8
4) Perfluorobut-2-ene, 2-C4F8, CAS 360-89-4
5) Any molecule with a C=C-C backbone and 6 atoms, including at least one F atom, zero or more H atoms, and zero or more Cl atoms.
6) Carbon monoxide, CO, CAS 630-08-0

and at least one of the following gases:

1) Sulfur hexafluoride, SF6, CAS 2551-62-4
2) Perfluoroisobutrylronitrile, (CF3)2CFCN, Novec 4710, CAS 42532-60-5
3) Heptafluoroisopropyl trifluoromethyl ketone, CF3C(O)CF(CF3)2, Novec 5110, CAS 756-12-7
4) Tetrafluoromethane, CF4, CAS 75-73-0
5) Trifluoriodomethane, CF3I, CAS 2314-97-8

Medium or high voltage electrical apparatus comprising a sealed enclosure in which there are electrical components and a gas mixture ensuring electrical insulation and/or extinguishing of electric arcs likely to occur in this enclosure, the gas mixture comprising ***gas***

Use of a ***gas*** as electrical isolation gas and/or electric arc extinguishing medium in a high voltage electrical apparatus.

Apparatus for the generation, measurement, transmission, distribution and/or usage of electrical energy, said apparatus comprising a housing enclosing an insulating space and an electrically conductive part arranged in the insulating space said insulating space containing a dielectric insulation fluid comprising a ***gas***

Switching device for medium, high or very high voltage, wherein at least one electric current transporting component of the switching device in an encapsulation is encapsulated and the encapsulation is filled with a filling medium, characterized in that the filling medium contains or consists of at least one compound from the group of ***gas***

A method for dielectrically insulating an electrical active part wherein the electrical active part is arranged in a gas-tight housing comprising an insulating medium consisting of, consisting essentially of, or comprising a compound of general formula : ***gas***
Apparatus for the generation, measurement, the distribution and/or the usage of electrical energy, said apparatus comprising a housing enclosing an insulating space and an electrical component arranged in the insulating space, said insulating space containing a dielectric insulation gas comprising an organofluorine compound A, the apparatus further comprising a molecular sieve arranged such as to come into contact with the insulation gas, the molecular sieve having an average pore size \( y \) greater than the molecular size of at least one decomposition product of the gas generated during operation of the apparatus, the adsorption capability and/or absorption capability of the molecular sieve for the
Medium or high voltage electrical apparatus comprising a sealed enclosure in which there are electrical components and a gas mixture ensuring the electrical insulation and/or extinguishing of electric arcs likely to occur in this chamber, the gas mixture comprising ***gas***, carbon dioxide and oxygen, the oxygen being present in said gaseous medium in a molar percentage of between 1 and 25%.

A high or medium voltage switch comprising a first and a second terminal, a first and a second set of contact elements arranged between the first and the second terminal, at least a first drive adapted to mutually displace the sets of contact elements along a displacement direction (D), wherein each contact element comprises an insulating carrier carrying at least one conducting element, and wherein in a first mutual position of said contact elements the conducting elements of said contact elements form at least one conducting path in an axial direction (A) between said first and said second terminals in a direction transversally to said displacement direction (D), and wherein in a second mutual position of said contact element the conducting elements are mutually displaced and do not form said conducting path, characterized in that said first and second contact elements are encapsulated in a fluid-tight housing and wherein said fluid-tight housing (1) contains an ***gas*** surrounding said contact elements.

Apparatus for the generation, measurement, transmission, distribution and/or usage of electrical energy, said apparatus comprising a housing enclosing an insulating space and an electrical component arranged in the insulating space, said insulating space containing a dielectric insulation gas comprising a ***gas*** compound, the apparatus further comprising a desiccant arranged such as to come into contact with the dielectric insulation gas, characterized in that the desiccant contains or essentially consists of lithium bromide.

Use of a mixture comprising a ***gas*** and a carrier gas as an electrical isolation medium and/or electric arc extinguishing in a medium and/or high voltage electrical apparatus, wherein the ***gas*** is present in the mixture in a molar percentage of at least 95% of the molar percentage M determined by the following formula (I): \[ M = \left( \frac{P_{\text{gas}}}{P_{\text{mixture}}} \right) \times 100 \] (I) in which: - \( P_{\text{mixture}} \) represents the pressure, expressed in kilopascals, of the mixture at 20 °C in the electrical apparatus; and - \( P_{\text{gas}} \) represents the pressure, expressed in kilopascals, which is equivalent to 20 °C to the saturation vapor pressure of the "gas" at the minimum temperature of use of the electrical apparatus, \( P_{\text{gas}} \) being determined by formula (II) below: \[ P_{\text{gas}} = \left( \frac{P_{\text{Vgas}} \times 293}{T_{\text{minimal}}} \right) \] in which: \( P_{\text{Vgas}} \) represents the saturation vapor pressure of the ***gas*** at the minimum temperature of use of the electrical appliance, expressed in kilopascals; and \( T_{\text{minimal}} \) represents the minimum temperature of use of the electrical appliance or service temperature, expressed in Kelvins.

A circuit breaker comprising at least one ejection device, said ejection device comprising a compartment, in which an arc-extinction medium and/or exhaust-cooling medium for improving circuit breaker operation, and in particular an arc-extinction medium for improving extinction of an arc formed during a breaker operation, is contained, and having at least one ejection orifice through which the arc-extinction medium and/or exhaust-cooling medium is to be ejected, wherein the ejection orifice opens out into an injection zone of the circuit breaker in which the pressure is lower than in an arcing zone when an arc is present, and wherein the arc-extinction medium and/or exhaust-cooling medium is one or more of a ***gas***, preferably the gas is at least partially present in liquid form, when it is contained in the ejection device.
Electrical apparatus for generation, transmission, distribution and/or usage of electrical energy, the electrical apparatus comprising a housing enclosing an electrical apparatus interior space, at least a portion of said electrical apparatus interior space comprising at least one insulation space, in which an electrical component is arranged and which contains an insulation medium surrounding the electrical component, the insulation medium comprising one or more of a gas and at least one further component in gaseous phase, the electrical apparatus further comprising a gas flow generating device designed to generate a flow of an initial gas mixture through an outlet opening arranged in the housing out of the insulation space, the initial gas mixture containing one or more of gas and at least one further component of the insulation medium, wherein downstream of the outlet opening a substance recovery device is arranged, the substance recovery device comprising a separator for separating the gas from the at least one remaining component of the initial gas mixture, said separator being or comprising a liquefaction device adapted for liquefying and/or a solidification device adapted for solidifying the gas.

A grounded tank that is filled with an insulating gas; a central conductor that is provided inside the grounded tank and to which a voltage is applied; an insulating support member that is attached to the grounded tank and that supports the central conductor in an insulating manner; a first non-linear resistance part that is provided on an inner surface of the grounded tank on a lower side and that has a first non-linear resistance material contained in a first insulating material; and a second non-linear resistance part that is provided on a surface of the first non-linear resistance part and that has a second non-linear resistance material contained in a second insulating material, wherein the first non-linear resistance part has a higher electric field strength at which a resistivity changes than the second non-linear resistance part.

Apparatus for the generation, measurement, transmission, distribution and/or usage of electrical energy, said apparatus comprising a housing enclosing an insulating space and an electrical component arranged in the insulating space, said insulating space containing a dielectric insulation gas comprising one or more of gas, the apparatus further comprising a desiccant arranged such as to come into contact with the dielectric insulation gas, wherein the desiccant contains or essentially consists or consists of lithium bromide.

Dielectric insulation medium comprising an insulation gas, said insulation gas comprising at operational conditions a gas, wherein the gas has a boiling point of at least -5°C at ambient pressure, preferably has a boiling point of at least -20°C at ambient pressure, even more preferably has a boiling point of at least -25°C or -30°C at ambient pressure.

An electrical apparatus having a gas insulation for medium- and/or high-voltages, comprising: a gas-tight housing including an inner space filled with an electrically insulating gas including at least one gas with a global warming potential GWP below 3500; at least one electrical component arranged in the inner space of the housing; means for regulating a quantity of gas in the inner space of the housing; a tank including an inner space communicating with the inner space of the housing, the housing configured such that a liquid formed by condensation is collected in the tank, and the means for regulating includes means for heating a liquid resulting from condensation of the gas present in the insulating gas, to cause the vaporization of at least part of the liquid.
A method for controlling heating means of a medium and/or high voltage gas-insulated electrical apparatus having an envelope whose interior volume is filled with a gas comprising at least one of ***gas*** and in which said envelope at least one electrical component is arranged, wherein the method consists in supplying the heating means when the temperature of the gas is lower than a threshold temperature which is defined in a manner such that the threshold temperature is greater than a dew point temperature of the gas, corresponding to the dew point of the ***gas***, and whose difference between said threshold temperature and the dew point temperature is equal to a predetermined value.

Dielectric insulation medium comprising a dielectric insulation gas, said insulation gas comprising a) one or more of ***gas***, in a mixture with b) a dielectric insulation gas component different from said one or more of ***gas*** a), wherein the dielectric gas component b) is a carrier gas that is present in a larger quantity than the one or more ***gas*** a) and that together with the one or more ***gas*** a) provides a non-linear increase of the dielectric strength of the insulation medium over the sum of dielectric strengths of the gas components of the insulation medium.

Apparatus for the generation, measurement, the distribution and/or the usage of electrical energy, said apparatus comprising a housing enclosing an insulating space and an electrically conductive part arranged in the insulating space, said insulating space containing a dielectric insulation medium, at least a portion of which being in the form of an insulation gas comprising one or more of ***gas***, wherein at least some of the components of the apparatus that are directly exposed to the insulation gas are made of a material which remains unaltered during exposure to the insulation gas for a period of more than 1 year at operational conditions and/or have a surface, at least a portion of which is devoid of any nucleophilic group reactive towards the one or more ***gas*** and/or reactive towards any degradation product of the one or more ***gas*** at operational conditions.

Electrical apparatus for generation, transmission, distribution and/or usage of electrical energy, the electrical apparatus comprising a housing enclosing an electrical apparatus interior space, at least a portion of said electrical apparatus interior space comprising at least one insulation space, in which an electrical component is arranged and which contains an insulation medium surrounding the electrical component, the insulation medium comprising an one or more of ***gas*** and at least one further component in gaseous phase, the electrical apparatus further comprising a gas flow generating device designed to generate a flow of an initial gas mixture through an outlet opening arranged in the housing out of the insulation space, the initial gas mixture containing one or more of ***gas*** and at least one further component of the insulation medium, wherein downstream of the outlet opening a substance recovery device is arranged, the substance recovery device comprising a separator for separating the one or more ***gas*** from the at least one remaining component of the initial gas mixture, said separator being or comprising a liquefaction device (36) adapted for liquefying and/or a solidification device adapted for solidifying the one or more ***gas***.

A device designed for interrupting non-short-circuit currents only, the device comprising: at least two contacts movable in relation to each other between a closed state and an open state and defining an arcing region, in which an arc is generated during a current interrupting operation and in which an arc-quenching medium comprising one or more of ***gas*** is present, wherein a counter-arcing component (19) is allocated to the arcing region and is designed for counteracting the generation of the arc and/or is designed for supporting extinction of the arc.
Method for diagnosing, monitoring and/or predicting a condition of a switching apparatus, in particular its dielectric insulation capability and/or arc extinction capability, the switching apparatus containing an insulation medium comprising at least one ***gas*** C1, the method comprising the method elements of:

a) selecting at least one physical quantity x of the insulation medium;
b) determining the difference between a value xSo of the physical quantity x at an initial state SO of the apparatus and a value xSi of the physical quantity x at a second state SI, said second state SI being later in time than the initial state SO, and
c) deducing from the difference between xSo and xSi the decrease in the amount of the at least one ***gas*** C1 and/or of the total amount of the at least one ***gas*** C1 present in the switching apparatus,

wherein the physical quantity x is the amount of at least one decomposition product C2 of the at least one ***gas*** C1 or is a physical quantity dependent on the amount of at least one decomposition product C2 of the at least one ***gas*** C1.

Dielectric insulation medium comprising

a) sulphur hexafluoride (SF6) and/or tetrafluoro methane (CF4), in a mixture with

b) at least one further component being one or more of ***gas***.

Use of a gaseous medium comprising 1) a three-carbon hydrofluoroolefin and one or more of ***gas*** or 2) a five-carbon fluoroketone and one or more of ***gas***, as an electrical isolation medium and/or electric arc extinguishing in medium voltage substation electrical apparatus.

Medium or high voltage electrical apparatus comprising a sealed enclosure in which there are electrical components and a gas mixture ensuring electrical insulation and/or extinguishing of electric arcs likely to occur in this enclosure, the gas mixture comprising one or more of ***gas***, carbon dioxide and oxygen, the oxygen being present in said gaseous medium in a molar percentage of between 1 and 25%.

A high or medium voltage switch comprising a first and a second terminal, a first and a second set of contact elements arranged between the first and the second terminal, at least a first drive adapted to mutually displace the sets of contact elements along a displacement direction,

wherein each contact element comprises an insulating carrier carrying at least one conducting element, and

wherein in a first mutual position of said contact elements the conducting elements of said contact elements form at least one conducting path in an axial direction between said first and said second terminals in a direction transversally to said displacement direction, and wherein in a second mutual position of said contact elements the conducting elements are mutually displaced and do not form said conducting path,

wherein said first and second contact elements are encapsulated in a fluid-tight housing and wherein said fluid-tight housing contains an electrically insulating fluid surrounding said contact elements, wherein the insulating fluid contains one or more of ***gas***.

A vacuum circuit breaker comprising a tank enclosing a tank interior space, and a vacuum interrupter comprising a vacuum flask which is arranged in the tank interior space and which encloses a vacuum space within which a pair of electrical contacts that are moveable in respect to each other between a closed position and an open position is arranged, the contacts each being supported by a conductive stem extending from the vacuum space to the outside of the vacuum space, with at least one conductive stem being moveably fitted in a bellow of the vacuum flask in a gas-tight manner, the portion of the tank interior space surrounding the vacuum interrupter forming at least one insulation space, at least one of which containing a dielectric insulation medium which comprises an on or more of ***gas*** having a
Global Warming Potential lower than the one of SF6, wherein at operating conditions of the circuit breaker the one or more ***gas*** is at least partially in liquid state and at least a portion of the vacuum interrupter is immersed in the liquid one or more ***gas***.

Electrical switching device having a longitudinal axis, comprising an arcing volume and at least an arcing contact arrangement with a first arcing contact and a mating second arcing contact, and further comprising an exhaust system with at least one exhaust volume, wherein for closing and opening the electric switching device at least one of the arcing contacts is movable parallel to the longitudinal axis and cooperates with the other arcing contact, wherein the electrical switching device comprises a dielectric insulating medium comprising an one or more of ***gas***, wherein inside the exhaust volume at least one intermediate volume is arranged, is enclosed by an intermediate wall, comprises at least one inlet opening for receiving exhaust gas coming from the arcing region, and comprises at least one outlet opening, which outlet opening is facing an opposing wall, in particular of the exhaust volume, and is for producing at least one exhaust gas jet and for discharging it towards and impacting it on the opposing wall, and wherein the intermediate volume is designed such that at least temporarily during a time period of exhaust gas ejection an intermediate exhaust gas pressure in the intermediate volume exceeds an exhaust gas pressure in its immediately succeeding exhaust volume at least by a pressure ratio K larger than 1.1.

Refill-container for replenishing and/or reconditioning an insulation fluid contained in an insulation space of an electrical apparatus, at least a portion of the interior of the refill-container defining a refill-fluid containment space, in which a refill-fluid comprising one or more of ***gas*** is contained, wherein the refill-container further comprises an opening designed to be brought from a sealed state, in which the refill-fluid is hermetically contained in the refill-containment space, to an open state, in which the refill-fluid is allowed to flow through the opening out of the refill-containment space.