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(54) **Method and apparatus for generating current and gypsum from hydrogen-sulphide-containing exhaust gases.**

(57) The invention relates to a method and an apparatus for generating current from hydrogen sulphide-containing exhaust gases, particularly from the natural gas industry.
The method according to the invention is characterized in that the hydrogen sulphide-containing exhaust gases are delivered to a current generation device and are burnt there, preferably with air being supplied, the energy released during combustion being employed at least partially for current generation.
The apparatus according to the invention is characterized by a current generation device in which supplied hydrogen sulphide-containing exhaust gases are burnt, preferably with air being supplied, the energy released during combustion being employed at least partially for current generation.

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Method and apparatus for generating current and gypsum from hydrogen-sulphide-containing exhaust gases

Description

The invention relates to a method and an apparatus for generating current from hydrogen sulphide-containing exhaust gases, in particular from the natural gas and petroleum industry.

Exhaust gases, particularly exhaust gases from the natural gas and petroleum industry, are often simply torched off without further utilization, that is to say, when the exhaust gas emerges from a chimney or pipe into the environment, it is burnt without its energy being utilized. The corresponding quantity of carbon dioxide is in this case discharged into the environment.

These exhaust gases contain hydrogen sulphide and therefore present problems for energy utilization, but are basically useful.

The object on which the present invention is based is to specify a method and an apparatus enabling the energy of hydrogen sulphide-containing exhaust gases to be utilized.

This object is achieved in terms of the method by means of the features of Claim 1 and in terms of the apparatus by means of the features of Claim 10. Advantageous refinements and developments are specified in the respectively dependent claims.

The invention provides a method for generating current from hydrogen sulphide-containing exhaust gases, particularly from the natural gas and petroleum industry, in which the hydrogen sulphide-containing exhaust gases are delivered to a current generation device and are burnt there, preferably with air being supplied. The energy released during combustion

is employed at least partially for current generation.

The advantages of the invention are, in particular, that the hydrogen sulphide-containing gases no longer escape, unused, but instead their energy is utilized in that they are employed for current generation.

Preferably, the combustion temperature of the hydrogen sulphide-containing exhaust gases is at least about 1300°C. The advantage of this is that, at such high combustion temperatures, even harmful attendant substances, such as carbon monoxide and benzene, burn completely to form carbon dioxide and water and therefore occur no longer, or at least to only a markedly reduced extent, in the combustion exhaust gas.

There is provision in a development of the invention for the current generation device to comprise a steam generator which is part of the thermodynamic circuit of a steam power process which, in turn, comprises a steam turbine following the steam generator and a condenser following the steam turbine. The combustion of the hydrogen sulphide-containing exhaust gases takes place in the steam generator. The energy released in this case is employed at least partially for steam generation. Finally, current generation takes place by means of a generator driven by the steam turbine. There may also be provision for the steam to be at least partially branched off and delivered for thermal utilization, for example for heating or warming purposes. In this case, the method according to the invention is a method for generating current and steam from hydrogen sulphide-containing exhaust gases, particularly from the natural gas industry.

Alternatively or additionally, the current generation device may also comprise a gas turbine and/or a gas engine. Current generation in this case takes place by means of a generator driven by the gas turbine and/or by the gas engine.

Further, according to a development of the invention, there may be provision for the composition of the hydrogen sulphide-containing exhaust gases to be measured before combustion and to be compared with a stipulated composition or stipulated composition bandwidth. In the event of a deviation from the stipulated composition or composition bandwidth, an additional fraction of natural gas and/or other substances, in particular gases, which is required for correction, is determined and is admixed to the hydrogen sulphide-containing exhaust gases before combustion. It can thereby be ensured that the composition of the exhaust gases to be burnt is as optimal as possible for the method and, in particular, for the combustion of the exhaust gases which is provided in this case.

For example, the stipulated composition or stipulated composition bandwidth of the hydrogen sulphide-containing exhaust gases may provide the following fractions as a molar percentage:
hydrogen sulphide: 1% to 10%, in particular 3% to 7%, preferably about 6%, and/or
carbon dioxide: 10% to 90%, in particular 60% to 70%, preferably about 65%, and/or
nitrogen: 0.0% to 2.0%, in particular 0.2% to 0.6%, preferably about 0.4%, and/or
methane: 0.1% to 65%, in particular 12% to 20%, preferably about 16%, and/or
ethane: 0.1% to 20%, in particular 2% to 8%, preferably about 5%, and/or
hydrocarbons (C4 to C9): 0.01% to 40%, in particular 4% to 10%, preferably about 7%.

There is provision in a development of the invention for the sulphur oxide-containing, in particular sulphur dioxide-containing and sulphur trioxide-containing combustion exhaust gases which occur during the combustion of the hydrogen sulphide-containing exhaust gases to be delivered for flue gas desulphurization. Since the combustion exhaust gases have a very high sulphur oxide fraction (in particular, sulphur dioxide and sulphur tri-

oxide fraction), as compared with customary combustion exhaust gases, it may be expedient to provide multi-stage flue gas desulphurization, preferably multi-stage flue gas desulphurization comprising a solid-bed reactor for sulphur trioxide separation and a lime scrub (wet scrub) for sulphur dioxide separation.

For example, with regard to multi-stage flue gas desulphurization, sulphur trioxide can be separated in a solid-bed reactor in one method stage, preferably in a first method stage. In another method stage, sulphur dioxide can be separated in the wet scrub. Limestone, for example with a 4/6 mm grain size, can be used in the solid-bed reactor. About 80% sulphur trioxide can thereby be separated. Limestone powder, for example with a grain size of 90% below 0.063 mm, can be used for the wet scrub. About 99% sulphur dioxide can thereby be separated.

By means of multi-stage flue gas desulphurization of this type, for example, 20 000 to 50 000 mg/m^3 of sulphur dioxide and 600 to 1500 mg/m^3 of sulphur trioxide can be separated from the combustion exhaust gases.

A substantial advantage of this multi-stage flue gas desulphurization is the separation of sulphur trioxide. Sulphur trioxide would pass, unchanged, through a straightforward wet scrub, that is to say, without the solid-bed reactor in one of the method stages, the sulphur trioxide would reach the chimney and form an aerosol mist at the chimney outlet. The fraction of sulphur trioxide is very high precisely in the combustion, provided according to the invention, of hydrogen sulphide-containing exhaust gases, particularly from the natural gas and petroleum industry, and multi-stage flue gas desulphurization with a solid-bed reactor for separating sulphur trioxide assumes correspondingly serious importance here.

The gypsum occurring during flue gas desulphurization is delivered to a gypsum mill for the production of gypsum products, for example gypsum plasterboards and/or ready-prepared gypsum mixtures. The method according to the invention is then a method for generating current and gyp-

sum from hydrogen sulphide-containing exhaust gases, particularly from the natural gas and petroleum industry.

The abovementioned gypsum mill can satsify its demand for electrical energy completely or partially from current generation as a result of the combustion of hydrogen sulphide-containing exhaust gases. There may also be provision for the gypsum mill to derive its heat demand completely or partially from the combustion gases occurring during the combustion of the hydrogen sulphide-containing exhaust gases and/or from the current generation processes, in particular the thermodynamic circuit of the steam power process. If there is provision for deriving the heat demand completely or partially from the steam power process, this may take place in that steam is branched off and is delivered directly to the gypsum mill for heating or warming purposes. For example, the steam may be employed for warming the drying and/or calcining devices for the gypsum mill. If the steam is also utilized thermally, the method according to the invention is a method for generating current, gypsum and steam from hydrogen sulphide-containing exhaust gases, particularly from the natural gas and petroleum industry. A substantial advantage in this case is that a discharge of carbon dioxide from the gypsum mill into the environment can thus be avoided.

The apparatus according to the invention is an apparatus for generating current from hydrogen sulphide-containing exhaust gases, in particular from the natural gas and petroleum industry. The apparatus comprises a current generation device in which delivered hydrogen sulphide-containing exhaust gases are burnt, preferably with air being supplied, the energy released during combustion being employed at least partially for current generation.

This apparatus is preferably operated by means of the above-described method according to the invention.

The advantages of the apparatus according to the invention are in turn, in

particular, that the hydrogen sulphide-containing gases no longer escape, unused, but instead their energy is utilized in that they are employed for current generation.

Preferably, the combustion temperature of the hydrogen sulphide-containing exhaust gases is at least about 1300°C, as in the method according to the invention.

There is provision in a development of the apparatus for the current generation device to comprise a steam generator which is part of the thermodynamic circuit of a steam power process, which, in turn, comprises a steam turbine following the steam generator and a condenser following the steam turbine. The combustion of the hydrogen sulphide-containing exhaust gases takes place in the steam generator, and the energy released is employed at least partially for steam generation. Furthermore, a generator driven by the steam turbine is provided for current generation. In the apparatus, there may also be provision for the steam to be at least partially branched off and delivered for thermal utilization, for example for heating or warming purposes. In this case, the apparatus according to the invention is an apparatus for generating current and steam from hydrogen sulphide-containing exhaust gases, particularly from the natural gas and petroleum industry.

Alternatively or additionally, the current generation device may comprise a gas turbine and/or a gas engine, a generator driven by the gas turbine and/or by the gas engine being provided for current generation.

Further, according to a development of the apparatus according to the invention, a measuring device for determining the composition of the hydrogen sulphide-containing exhaust gases before combustion and an evaluation device for comparing the composition determined with a stipulated composition or with a stipulated composition bandwidth may be provided. In this case, it is expedient, furthermore, to provide a control device and a supply device for natural gas and/or other substances, in particular gases.

The control device is designed and set up in such a way that, in the event of a deviation, determined by the evaluation device, from the stipulated composition or composition bandwidth, it determines an additional fraction of natural gas and/or other substances, in particular gases, which is required for correction and admixes it to the hydrogen sulphide-containing exhaust gases via the supply device before combustion. It can thereby be ensured that the composition of the exhaust gases to be burnt is as optimal as possible for the apparatus and, in particular, for the combustion of the exhaust gases which is provided in it.

For example, the stipulated composition or stipulated composition bandwidth of the hydrogen sulphide-containing exhaust gases may provide the following fractions as molar percentages:
hydrogen sulphide: 1% to 10%, in particular 3% to 7%, preferably about 6%, and/or
carbon dioxide: 10% to 90%, in particular 60% to 70%, preferably about 65%, and/or
nitrogen: 0.0% to 2.0%, in particular 0.2% to 0.6%, preferably about 0.4%, and/or
methane: 0.1% to 65%, in particular 12% to 20%, preferably about 16%, and/or
ethane: 0.1% to 20%, in particular 2% to 8%, preferably about 5%, and/or
hydrocarbons (C4 to C9): 0.01% to 40%, in particular 4% to 10%, preferably about 7%.

There is provision in a development for the apparatus to comprise flue gas desulphurization which purifies sulphur oxide-containing, in particular sulphur dioxide-containing and sulphur trioxide-containing combustion gases occurring during the combustion of the hydrogen sulphide-containing exhaust gases, gypsum being obtained. Since the combustion exhaust gases have a very high sulphur oxide fraction (in particular, sulphur dioxide and sulphur trioxide fraction), as compared with customary combustion exhaust gases, it may be expedient to provide multi-stage flue gas desul-

phurization, preferably multi-stage flue gas desulphurization comprising a solid-bed reactor for sulphur trioxide separation and a lime scrub for sulphur dioxide separation.

Reference may be made, for further explanations and advantages regarding multi-stage flue gas desulphurization, to the above statements in connection with the method according to the invention.

Further, the apparatus according to the invention may comprise a gypsum mill which employs the gypsum occurring during flue gas desulphurization for the production of gypsum products, for example in the production of gypsum plasterboards and/or ready-prepared gypsum mixtures. The apparatus according to the invention is then an apparatus for generating current and gypsum from hydrogen sulphide-containing exhaust gases, particularly from the natural gas and petroleum industry.

The abovementioned gypsum mill may be set up in such a way that it satisfies its demand for electrical energy completely or partially from current generation as a result of the combustion of hydrogen sulphide-containing exhaust gases. The gypsum mill may also be set up in such a way that it derives its heat demand completely or partially from the combustion gases occurring during the combustion of the hydrogen sulphide-containing exhaust gases and/or from the current generation processes, in particular the thermodynamic circuit of the steam power process. If there is provision for deriving the heat demand completely or partially from the steam power process, this may take place in that steam is delivered directly, via a branch-off, to the gypsum mill for heating or warming purposes. For example, the steam may be employed for warming the drying and/or calcining devices of the gypsum mill. If the steam is also utilized thermally, the apparatus according to the invention is an apparatus for generating current, gypsum and steam from hydrogen sulphide-containing exhaust gases, particularly from the natural gas and petroleum industry. A substantial advantage in this case is that a discharge of carbon dioxide from the gypsum mill into the environment can thereby be avoided.

The invention is also explained in more detail below with regard to further features and advantages by means of the description of exemplary embodiments and with reference to the accompanying diagrammatic drawings in which:

FIG. 1 shows a first exemplary embodiment of the method according to the invention and of the apparatus according to the invention,

FIG. 2 shows a second exemplary of the method according to the invention and of the apparatus according to the invention, and

FIG. 3 shows a third exemplary embodiment of the method according to the invention and of the apparatus according to the invention.

Parts and components corresponding to one another are designated in the figures by the same reference symbols.

FIG. 1 to FIG. 3 show three different exemplary embodiments of the invention. The figures illustrate, by means of the respective exemplary embodiment, both the method 1 according to the invention and the apparatus 1 according to the invention for generating current from hydrogen sulphide-containing exhaust gases 3 from the natural gas and petroleum industry 2. Of course, the method 1 and apparatus 1 can also be employed for hydrogen sulphide-containing exhaust gases 3 from other sources.

In the first exemplary embodiment according to FIG. 1, the incoming hydrogen sulphide-containing exhaust gases 3 are first delivered to an exhaust-gas mixing device 17, the task of which is to provide an exhaust gas 3, the composition of which corresponds to a stipulated composition or lies within a stipulated composition bandwidth. Examples of this stipulated composition or composition bandwidth have already been given above in the general description.

The exhaust-gas mixing device 17 comprises a measuring device 12, by

means of which the composition of the incoming hydrogen sulphide-containing exhaust gases 3 is determined. Further, the exhaust-gas mixing device 17 comprises an evaluation device 13 which compares the composition determined with the stipulated composition or with the stipulated composition bandwidth.

Furthermore, the exhaust-gas mixing device 17 comprises a control device 14 and a supply device 15 for natural gas and/or other substances, in particular gases. In the event of a deviation, determined by the evaluation device 13, from the stipulated composition or composition bandwidth, the control device 14 determines an additional fraction of natural gas and/or other substances which is required for correction, and cooperates with the supply device 15 in such a way that the determined fraction of natural gas and/or other substances which is required for correction is admixed as admixing gas 16 to the hydrogen sulphide-containing exhaust gas 3 via the supply device 15 before combustion.

Subsequently, the hydrogen sulphide-containing exhaust gases 3, the composition of which is corrected where appropriate, are delivered to a current generation device 4. The current generation device 4 in the exemplary embodiment according to FIG. 1 comprises a thermodynamic circuit 11 of a steam power process. For this purpose, the current generation device comprises a steam generator 6 to which the exhaust gas 3 is supplied. The hydrogen sulphide-containing exhaust gases 3 are burnt in the steam generator 6, with air 5 being supplied, preferably at a combustion temperature of about 1300°C. The energy released is employed in the steam generator 6 at least partially for steam generation.

The current generation device 4 comprises, furthermore, a steam turbine 7 which follows the steam generator 6. The steam turbine 7 is supplied with the steam 10 generated by the steam generator 6. The steam turbine 7, in turn, is coupled to a generator 8 which is driven by the steam turbine 7 for the generation of current 24. The generated current 24 can be fed into a public power network 25 and/or be made available for electrical consumers.

Further, the current generation device 4 comprises a condenser 9 which follows the steam turbine 7, that is to say, after flowing through the steam turbine 7, the steam 10 is supplied to the condenser 9. This is preferably an air-cooled condenser 9.

After condensation in the condenser 9, the condensed liquid and/or steam still present is supplied again to the steam generator 6, and the thermodynamic circuit 11 of the steam power process is thereby closed.

Alternatively, it is also possible to interrupt the thermodynamic circuit 11 and, on the principle of conventional combined heat and power generation, to utilize the thermal energy still contained in the steam after the latter flows through the steam turbine 7, in other ways, for example for heating purposes within the framework of nearby or distant heating devices. In this case, water has to be supplied to the thermodynamic circuit 11 of the steam power process of the current generation device 4 for compensation upsteam of the steam generator 6, that is to say there is no longer a circulatory process in the actual sense. This alternative is not illustrated in the figures.

During the combustion of the hydrogen sulphide-containing exhaust gases 3 in the steam generator 6, combustion gases 18 arise. These are delivered for flue gas desulphurization 19, purified there and subsequently discharged as purified exhaust gas 20, for example directly into the environment, although this may also be followed or preceded by further exhaust-gas purification steps.

On account of the hydrogen sulphide content of the initial gases, the combustion gases have a very high sulphur dioxide and sulphur trioxide fraction, as compared with combustion exhaust gases from known plants. Correspondingly, flue gas desulphurization 19 suitable for this purpose must be provided, for example multi-stage flue gas desulphurization, preferably multi-stage flue gas desulphurization 19 comprising a solid-bed reactor for sulphur trioxide separation and a lime scrub for sulphur dioxide separation. The wa-

ter required for flue gas desulphurization can, if the apparatus is located near the sea, be extracted from the sea by means of seawater pumps.

The flue gas desulphurization 19 gives rise to gypsum 21 which is delivered to a gypsum mill 22 for the production of gypsum products 23. For example, gypsum plasterboards or ready-prepared gypsum mixtures are produced in this gypsum mill 22, using the gypsum 21.

The gypsum mill 22 is designed and set up in such a way that it satisfies its demand for electrical energy completely or partially from the current generated by the current generation device 4, that is to say the gypsum mill 22 is one of the abovementioned electrical consumers, for which the current generation device 4 makes available the current 24 generated from the combustion of the hydrogen sulphide-containing exhaust air.

Further, the gypsum mill 22 satisfies its heat demand completely or partially in that it branches off steam 26 from the above-described thermodynamic circuit 11 of the steam power process of the current generation device 4 and extracts heat energy for warming and/or heating purposes from this branched-off steam 26. For example, the branched-off steam 26 can thereby be employed for calcining the gypsum 21 and/or for drying gypsum plasterboards in the gypsum mill 22.

After this thermal utilization, the branched-off steam 26 can be released or used in other ways. In this case, water has to be supplied to the thermodynamic circuit 11 of the steam power process of the current generation device 4 for compensation. Or the branched-off steam 26 is recirculated, after thermal utilization, into the thermodynamic circuit 11 of the steam power processor of the current generation device 4, so that this circuit essentially continues to be closed in terms of the steam. The transfer of the branched-off steam 26 after thermal utilization and the supply, required if appropriate, of water to the thermodynamic circuit 11 are not illustrated in FIG. 1.

The second exemplary embodiment according to FIG. 2 and the third exemplary embodiment according to FIG. 3 correspond in terms of the exhaust-gas supply and exhaust-gas mixing device 17 to the first exemplary embodiment, and therefore reference is made for this purpose to the preceding statements relating to FIG. 1.

However, the second and third embodiments differ from the first exemplary embodiment in the current generation device 4 used. Instead of a steam power process, the current generation device 4 comprises in the second exemplary embodiment a gas turbine 27 and in the third exemplary embodiment a gas engine 28, in each case with a preceding compressor 31 for the exhaust air 3 supplied. The hydrogen sulphide-containing exhaust gases 3, the composition of which is again corrected if appropriate, are delivered to this gas turbine 27 or to this gas engine 28 and are burnt in the gas turbine 27 or gas engine 28, with air 5 being supplied, preferably at a combustion temperature of about 1300 °C. The gas turbine 27 or gas engine 28 is coupled to a generator 8 which is driven by the gas turbine 27 or gas engine 28 for the generation of current 24. As in the first exemplary embodiment according to FIG. 1, the generated current 24 can again be fed into a public power network 25 and/or made available for electrical consumers.

During the combustion of the hydrogen sulphide-containing exhaust gases 3 in the gas turbine 27 or gas engine 28, combustion gases 18 arise. These are conducted for further energy utilization through a heat exchanger 29 before

being transferred to flue gas desulphurization 19. In the heat exchanger 29, thermal energy is extracted from the combustion gases 18 and delivered via a suitable fluid circuit 30 to a gypsum mill 22, so that this gypsum mill 22 can thereby satisfy its heat demand completely or partially. For example, the heat extracted from the combustion gases 18 can thus be employed for calcining the gypsum 21 and/or for drying gypsum plasterboards in the gypsum mill 22.

All further features of the transfer of the combustion gases 18, of the flue gas desulphurization 19 and of the gypsum mill 22 correspond to the solution already discussed by means of the first exemplary embodiment according to FIG. 1, and therefore reference is made in this regard to the above statements.

To make the advantages of the invention clear, two power output balances of a method 1 or apparatus 1 according to the first exemplary embodiment described above by means of FIG. 1 are given below by way of example.

In both power output balances, the starting-point is hydrogen sulphide-containing exhaust air 3 with a supplied thermal power output of 100 MW(th). The unit MW stands for megawatts. The addition "th" makes it clear that it is a thermal power output, and the addition "el" used below makes it clear that it is an electrical power output.
During operation without a steam branch-off 26 for thermal utilization in the gypsum mill 22, the following power output is afforded:

Power network	21.0 MW(el)
Exhaust-gas mixing device	0.5 MW(el)
Steam generator	0.5 MW(el)
Condenser (air-cooled)	0.5 MW(el)
Flue gas desulphurization	1.5 MW(el)
Seawater pumps (for flue gas desulphurization)	0.5 MW(el)
Gypsum mill	5.5 MW(el)

During operation with a steam branch-off 26 for thermal utilization in the gypsum mill 22 (steam flow with a pressure of 21 bar, 38 t/h, to a calcining device for gypsum and for gypsum plasterboard drying), the following power output is afforded:

Power network	11.0 MW(el)
Exhaust-gas mixing device	0.5 MW(el)
Steam generator	0.5 MW(el)
Condenser (air-cooled)	0.5 MW(el)
Flue gas desulphurization	1.5 MW(el)
Seawater pumps (for flue gas desulphurization)	0.5 MW(el)
Gypsum mill	5.5 MW(el)
Gypsum mill	24.0 MW(th)

List of reference symbols

1	Method/apparatus for generating current from hydrogen sulphide-containing exhaust gases
2	Natural gas and petroleum industry
3	Hydrogensulphide-containing exhaust gases
4	Current generation device
5	Air
6	Steam generator
7	Steam turbine
8	Generator
9	Condenser
10	Steam
11	Thermodynamic circuit of the steam power process
12	Measuring device
13	Evaluation device
14	Control device
15	Supply device
16	Admixing gas
17	Exhaust-gas mixing device
18	Combustion gases
19	Flue gas desulphurization
20	Purified exhaust gas
21	Gypsum
22	Gypsum mill
23	Gypsum products
24	Current
25	Public power network
26	Branched-off steam for the heat demand of the gypsum mill
27	Gas turbine
28	Gas engine
29	Heat exchanger
30	Fluid circuit
31	Compressor

Conclusies

1. Werkwijze (1) voor het opwekken van stroom uit waterstofsulfide bevattende afgassen (3), in het bijzonder uit de aardgas- en aardolie-industrie (2),
met het kenmerk, dat
de waterstofsulfide bevattende afgassen (3) toegevoerd worden aan een stroom opwekkende inrichting (4), en daar, bij voorkeur onder toevoer van lucht (5), verbrand worden, en dat de energie die vrijkomt gedurende de verbranding ten minste ten dele wordt toegepast voor de opwekking van stroom.

2. Werkwijze volgens conclusie 1,
met het kenmerk, dat
de verbrandingstemperatuur van waterstofsulfide bevattende afgassen (3) ten minste ongeveer 1300°C is.

3. Werkwijze volgens conclusie 1 of 2,
met het kenmerk, dat
de stroom opwekkende inrichting (4) een stoomgenerator (6) omvat die deel uitmaakt van het thermodynamisch circuit (11) van een stoomvermogenproces, dat op zijn beurt een stoomturbine (7) omvat na de stoom generator (6) en een condensor (9) na de stoom turbine (7), dat de verbranding van de waterstofsulfide bevattende afgassen (3) plaatsvindt in de stoom generator (6), en de energie die vrijkomt ten minste gedeeltelijk toegepast wordt voor het opwekken van stoom, en stroomopwekking plaatsvindt middels een generator (8) die aangedreven wordt door de stoomturbine (7).

4. Werkwijze volgens een of meer der voorgaande conclusies,
met het kenmerk, dat
de stroom opwekkende inrichting (4) een gasturbine (27) en/of een gasmotor (28) omvat, en dat stroomopwekking plaatsvindt middels

een generator (8) aangedreven door de gasturbine (27) en/of door de gasmotor (28).

5. Werkwijze volgens een of meer der voorgaande conclusies,
met het kenmerk, dat
de samenstelling van de waterstofsulfide bevattende afgassen(3) gemeten wordt (12) voor verbranding en vergeleken wordt (13) met een voorgeschreven samenstelling of voorgeschreven bandbreedte van de samenstelling en dat, in het geval van een afwijking van de voorgeschreven samenstelling of samenstelling bandbreedte, een aanvullende fractie aardgas en/of andere substanties (16), die vereist zijn voor correctie, wordt bepaald (14) en wordt bijgemengd (15) bij de waterstofsulfide bevattende afgassen voor verbranding.

6. Werkwijze volgens conclusie 5,
met het kenmerk, dat
de voorgeschreven samenstelling of voorgeschreven samenstelling bandbreedte van de waterstofsulfide bevattende afgassen(3) de volgende fracties als molaire percentages heeft:
waterstofsulfide: 1% tot 10%, in het bijzonder 3% tot 7%, bij voorkeur ongeveer 6%, en/of
kooldioxide: 10% tot 90%, in het bijzonder 60% tot 70%, bij voorkeur ongeveer 65%, en/of
stikstof: 0,0% tot 2,0%, in het bijzonder 0,2% tot 0,6%, bij voorkeur ongeveer 0,4%, en/of
methaan: 0,1% tot 65%, in het bijzonder 12% tot 20%, bij voorkeur ongeveer 16%, en/of
ethaan: 0,1% tot 20%, in het bijzonder 2% tot 8%, bij voorkeur ongeveer 5%, en/of
koolwaterstoffen (C4 tot C9): 0,01% tot 40%, in het bijzonder 4% tot 10%, bij voorkeur ongeveer 7%.

7. Werkwijze volgens een of meer der voorgaande conclusies,
met het kenmerk, dat

de zwaveldioxide bevattende en zwaveltrioxide bevattende verbrandingsafgassen (18) die ontstaan gedurende de verbranding van de waterstofsulfide bevattende afgassen (3) worden toegevoerd voor afrookgas ontzwaveling (19), dat de rookgas ontzwaveling resulteert in gips (21) dat toegevoerd wordt aan een gipsmolen (22) voor de productie van gips producten (23), in het bijzonder gipsplaten en/of kant-en-klaar bereide gips mengsels.

8. Werkwijze volgens conclusie 7,
met het kenmerk, dat
de rookgas ontzwaveling (19) een meerstaps stage flue gas ontzwaveling is, bij voorkeur omvattende een vast bed reactor voor zwaveltrioxide scheiding en een kalkwassing voor zwaveldioxide scheiding.

9. Werkwijze volgens conclusie 7 of 8,
met het kenmerk, dat
de gips molen (22) geheel of gedeeltelijk aan zijn behoefte aan elektrische energie uit stroomopwekking ten gevolge van de verbranding van de waterstofsulfide bevattende afgassen (3), en/of de gipsmolen (22) geheel of gedeeltelijk aan zijn behoefte aan warmte voldoet uit de verbrandingsgassen (18) die ontstaan gedurende verbranding van de waterstofsulfide bevattende afgassen (3) en/of van de stroomopwekkingsprocessen, in het bijzonder het thermodynamische circuit (11) van het stoom vermogen proces.

10. Inrichting (1) voor het opwekken van stroom uit waterstofsulfide bevattende afgassen (3), in het bijzonder van de aardgas- en aardolieindustrie (2), in het bijzonder middels een werkwijze volgens een of meer der voorgaande conclusies, gekenmerkt door een stroomopwekinrichting (4) waarin toegevoerde waterstofsulfide bevattende afgassen (3), bij voorkeur onder toevoer van lucht (5), worden verbrand, waarbij de energie die vrijkomt gedurende de verbranding ten minste ten dele wordt benut voor stroomopwekking.

11. Inrichting volgens conclusie 10,
met het kenmerk, dat
de verbrandings temperatuur van de waterstofsulfide bevattende afgassen (3) ten minste ongeveer 1300°C is.

12. Inrichting volgens conclusie 10 of 11,
met het kenmerk, dat
de stroom opwekkende inrichting (4) een stoom generator (6) omvat die deel uitmaakt van het thermodynamische circuit (11) van een stoom power proces, welke op zijn beurt een stoomturbine (7) omvat na de stoom generator (6) en een condensor (9) na de stoomturbine (7), dat de verbranding van de waterstofsulfide bevattende afgassen (3) plaatsvindt in de stoom generator (6), en de energie die vrijkomt ten minste gedeeltelijk toegepast wordt voor het opwekken van stoom, en een generator (8) aangedreven door de stoomturbine (7) verschaft is voor stroomopwekking.

13. Inrichting volgens een der conclusies 10 - 12,
met het kenmerk, dat
de stroom opwekkende inrichting (4) een gasturbine (27) en/of een gasmotor (28) omvat, en dat een generator (8) aangedreven door de gasturbine (27) en/of de gasmotor (28) verschaft is voor stroomopwekking.

14. Inrichting volgens one of conclusies 10 to 13,
met het kenmerk, dat
een meetinrichting (12) is voorzien voor het bepalen van de samenstelling van de waterstofsulfide bevattende afgassen (3) voor verbranding, een evaluatie inrichting (13) is voorzien voor het vergelijken van de bepaalde samenstelling met een voorgeschreven samenstelling of een samenstelling met een voorgeschreven bandbreedte, en een controle inrichting (14) en een toevoerinrichting (15) voor aardgas en/of andere substanties (16) voorzien zijn, waarbij in het geval van een afwijking, bepaald door de evaluatie inrichting (13),

van de voorgeschreven samenstelling of samenstellingsbandbreedte, de controle inrichting (14) een additionele fractie aardgas en/of andere substanties (16) bepaald, die nodig zijn voor correctie, en deze bijmengt bij de waterstofsulfide bevattende afgassen (3) via the toevoerinrichting (15) voor verbranding.

15. Inrichting volgens conclusie 14,
met het kenmerk, dat
de voorgeschreven samenstelling of voorgeschreven samenstellings bandbreedte waterstofsulfide bevattende afgassen (3) de volgende fracties als molaire percentages heeft:
waterstofsulfide: 1% tot 10%, in het bijzonder 3% tot 7%, bij voorkeur ongeveer 6%, en/of
kooldioxide: 10% tot 90%, in het bijzonder 60% tot 70%, bij voorkeur ongeveer 65%, en/of
stikstof: 0,0% tot 2,0%, in het bijzonder 0,2% tot 0,6%, bij voorkeur ongeveer 0,4%, en/of
methaan: 0,1% tot 65%, in het bijzonder 12% tot 20%, bij voorkeur ongeveer 16%, en/of
ethaan: 0,1% tot 20%, in het bijzonder 2% tot 8%, bij voorkeur ongeveer 5%, en/of
koolwaterstoffen (C4 tot C9): 0,01% tot 40%, in het bijzonder 4% tot 10%, bij voorkeur ongeveer 7%.

16. Inrichting volgens een of meer der conclusies 10 - 15,
met het kenmerk, dat
de inrichting (1) rookgas ontzwaveling (19) omvat voor het reinigen van zwaveldioxide-bevattende en zwaveltrioxide-bevattende verbrandingsgassen (18) die optreden gedurende de verbranding van de waterstofsulfide bevattende afgassen (3), waarbij gips (21) verkregen wordt, en dat de inrichting (1) een gipsmolen (22) omvat die de gips (21) die ontstaat gedurende de rookgas ontzwaveling (19) gebruikt voor de productie van gips producten (23), in het bijzonder voor de productie van gipsplaten en/of kant-en-klare gipsmengsels.

17. Inrichting volgens conclusie 16,
met het kenmerk, dat
de rookgas ontzwaveling (19) een meerstaps rookgas ontzwaveling, bij voorkeur omvattende een vast bed reactor voor zwaveltrioxide scheiding en een kalk lime scrub voor zwaveldioxide scheiding.

18. Inrichting volgens conclusie 16 or 17,
met het kenmerk, dat
de gips molen (22) geheel of gedeeltelijk aan zijn behoefte aan elektrische energie uit stroomopwekking ten gevolge van de verbranding van de waterstofsulfide bevattende afgassen (3), en/of de gipsmolen (22) geheel of gedeeltelijk aan zijn behoefte aan warmte voldoet uit de verbrandingsgassen (18) die ontstaan gedurende verbranding van de waterstofsulfide bevattende afgassen (3) en/of van de stroomopwekkingsprocessen, in het bijzonder het thermodynamische circuit (11) van het stoom vermogen proces.

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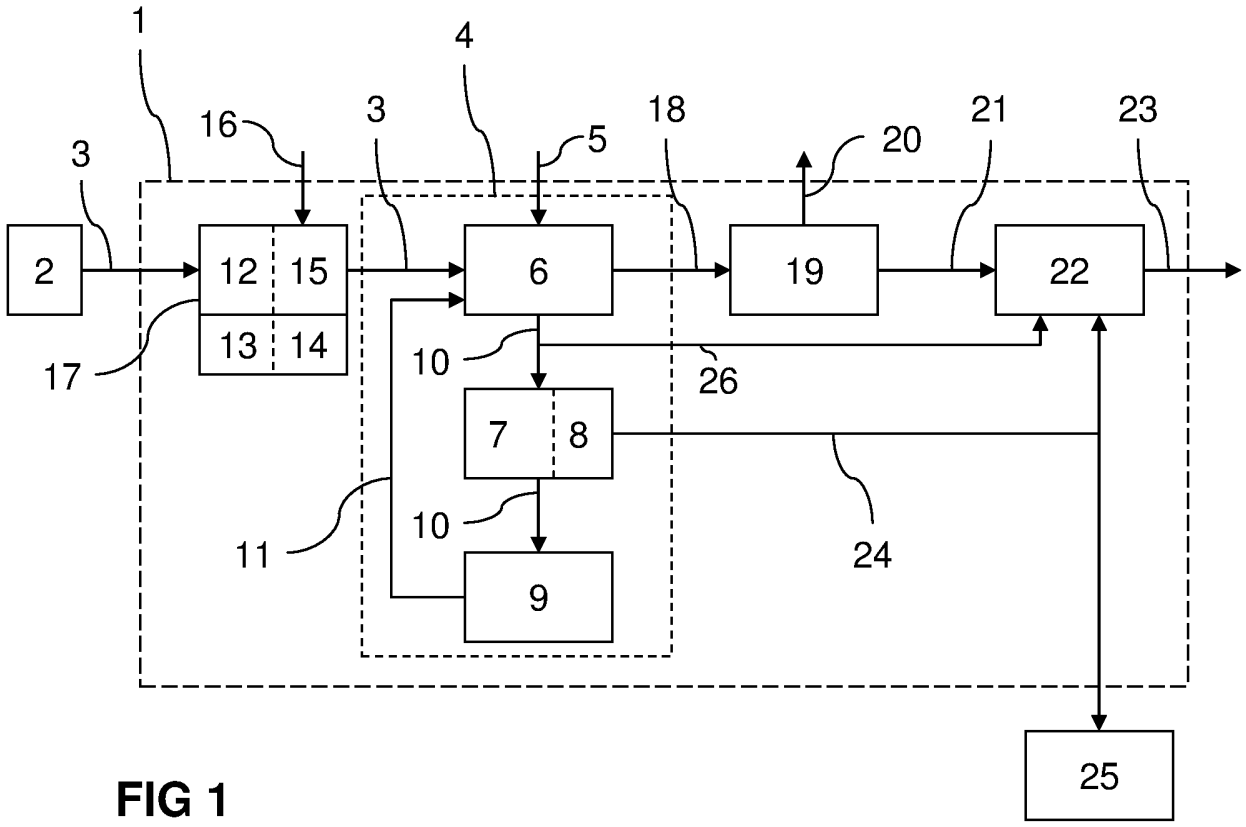

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FIG 1

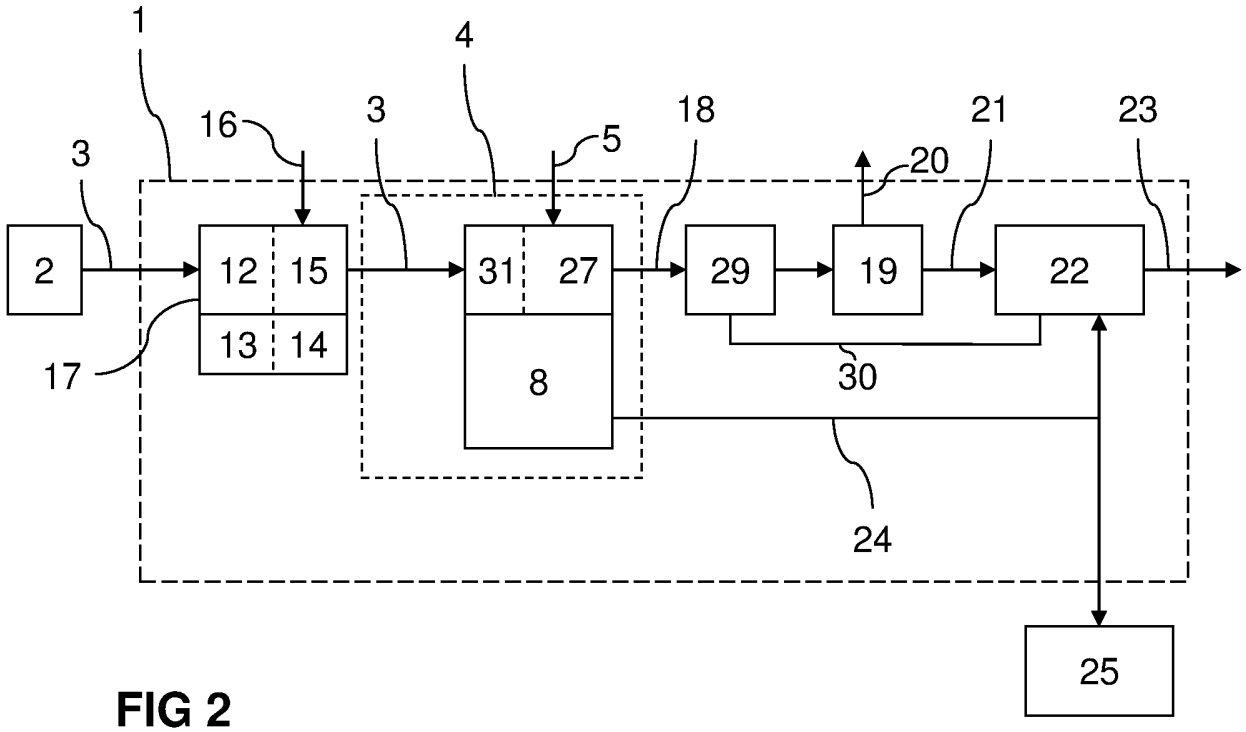

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FIG 2

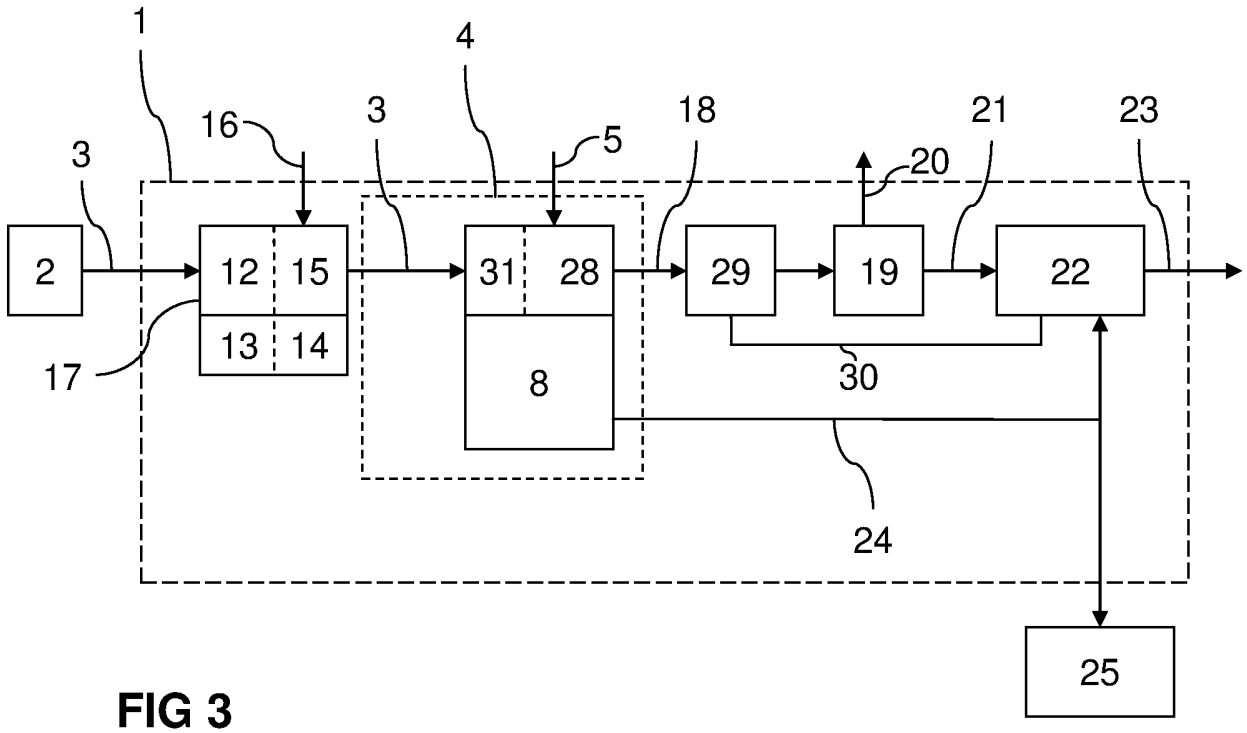


FIG 3

Agentschap NL
Ministerie van Economische Zaken, Landbouw en Innovatie

OCTROOIAANVRAAG NR.:
NO 138140
NL 2008012

ONDERZOEKSRAPPORT

BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK

RELEVANTE LITERATUUR

Categorie[1]	Literatuur met, voor zover nodig, aanduiding van speciaal van belang zijnde tekstgedeelten of figuren.	Van belang voor conclusie(s) nr:	Classificatie (IPC)
X	DE 199 39 390 A1 (STEINBRECHT DIETER [DE]; GEIER HELRATH [DE]) 22 februari 2001 (2001-02-22)	1,4,10, 13	INV. F23G7/06 F23G5/50
Y	* kolom 1, regel 3 - regel 33 * * kolom 4, regel 5 - regel 47; figuur *	7-9, 16-18	F02C3/30 F02C3/22

X	US 2009/226353 A1 (TEKIE ZERU BERHANE [US] ET AL) 10 september 2009 (2009-09-10)	1-3, 10-12	
Y	* alinea [0018] - alinea [0029] * * alinea [0058] - alinea [0059]; figuur 2 *	7-9, 16-18	

X	DE 25 24 861 A1 (LINDE AG) 16 december 1976 (1976-12-16)	1,4,10, 13	
Y	* bladzijde 1 - bladzijde 3 *	7-9, 16-18	

Y	US 2010/061906 A1 (BUSCHMANN JOHN [US] ET AL) 11 maart 2010 (2010-03-11) * alinea [0033] - alinea [0040]; figuur 1 *	7-9, 16-18	

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Onderzochte gebieden van de techniek

F23G
F02C
F23J

Indien gewijzigde conclusies zijn ingediend, heeft dit rapport betrekking op de conclusies ingediend op:

Plaats van onderzoek:	Datum waarop het onderzoek werd voltooid:	Bevoegd ambtenaar:
München	19 april 2012	Theis, Gilbert

[1] CATEGORIE VAN DE VERMELDE LITERATUUR

X: de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur
Y: de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht
A: niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft
O: niet-schriftelijke stand van de techniek
P: tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur
T: na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding
E: eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven
D: in de octrooiaanvrage vermeld
L: om andere redenen vermelde literatuur
&: lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

RELEVANTE LITERATUUR

Categorie[1]	Literatuur met, voor zover nodig, aanduiding van speciaal van belang zijnde tekstgedeelten of figuren.	Van belang voor conclusie(s) nr:
Y	Andrew M Dunster: "Flue gas desulphurisation (FGD) gypsum in plasterboard manufacture", , 30 november 2007 (2007-11-30), XP055024708, Gevonden op het Internet: URL:http://www.smartwaste.co.uk/filelibrary/Plasterboard_FGD_gypsum.pdf [gevonden op 2012-04-17] * het gehele document *	7-9, 16-18
A	DE 10 2008 037502 A1 (GEN ELECTRIC [US]) 7 mei 2009 (2009-05-07) * alinea [0005] - alinea [0027]; figuur *	5,6
A	US 2010/162678 A1 (ANNIGERI RAVINDRA [US] ET AL) 1 juli 2010 (2010-07-01) * alinea [0019] - alinea [0045]; figuren 1-4 *	5,6

[1] CATEGORIE VAN DE VERMELDE LITERATUUR

X: de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur
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T: na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding
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D: in de octrooiaanvrage vermeld
L: om andere redenen vermelde literatuur
&: lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

AANHANGSEL BEHORENDE BIJ HET RAPPORT BETREFFENDE HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK, UITGEVOERD IN DE OCTROOIAANVRAGE NR.

NO 138140
NL 2008012

Het aanhangsel bevat een opgave van elders gepubliceerde octrooiaanvragen of octrooien (zogenaamde leden van dezelfde octrooifamilie), die overeenkomen met octrooischriften genoemd in het rapport.
De opgave is samengesteld aan de hand van gegevens uit het computerbestand van het Europees Octrooibureau per
De juistheid en volledigheid van deze opgave wordt noch door het Europees Octrooibureau, noch door het Bureau voor de Industriële eigendom gegarandeerd; de gegevens worden verstrekt voor informatiedoeleinden.

19-04-2012

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
DE 19939390 A1	22-02-2001	GEEN	
US 2009226353 A1	10-09-2009	GEEN	
DE 2524861 A1	16-12-1976	GEEN	
US 2010061906 A1	11-03-2010	CN 102143795 A	03-08-2011
		EP 2321035 A1	18-05-2011
		TW 201016305 A	01-05-2010
		US 2010061906 A1	11-03-2010
		WO 2010027617 A1	11-03-2010
DE 102008037502 A1	07-05-2009	CH 698040 A2	15-05-2009
		CN 101424406 A	06-05-2009
		DE 102008037502 A1	07-05-2009
		JP 2009108858 A	21-05-2009
		US 2009107105 A1	30-04-2009
US 2010162678 A1	01-07-2010	CN 101793196 A	04-08-2010
		EP 2204561 A2	07-07-2010
		JP 2010156324 A	15-07-2010
		US 2010162678 A1	01-07-2010

EPO FORM P0466

Algemene informatie over dit aanhangsel is gepubliceerd in de 'Official Journal' van het Europees Octrooibureau nr 12/82 blz 448 ev

Agentschap NL
Ministerie van Economische Zaken, Landbouw en Innovatie

SCHRIFTELIJKE OPINIE

DOSSIER NUMMER	INDIENINGSDATUM	VOORRANGSDATUM	AANVRAAGNUMMER
NO138140	21.12.2011	28.04.2011	NL2008012

CLASSIFICATIE
INV. F23G7/06 F23G5/50 F02C3/30 F02C3/22

AANVRAGER
Knauf Gips KG

Deze schriftelijke opinie bevat een toelichting op de volgende onderdelen:

- ☒ Onderdeel I Basis van de schriftelijke opinie
- ☐ Onderdeel II Voorrang
- ☐ Onderdeel III Vaststelling nieuwheid, inventiviteit en industriële toepasbaarheid niet mogelijk
- ☐ Onderdeel IV De aanvraag heeft betrekking op meer dan één uitvinding
- ☒ Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid; inventiviteit en industriële toepasbaarheid
- ☐ Onderdeel VI Andere geciteerde documenten
- ☐ Onderdeel VII Overige gebreken
- ☐ Onderdeel VIII Overige opmerkingen

DE BEVOEGDE AMBTENAAR
Theis, Gilbert

Aanvraag nr.:

SCHRIFTELIJKE OPINIE

NL2008012

Onderdeel I Basis van de Schriftelijke Opinie

1. Deze schriftelijke opinie is opgesteld op basis van de meest recente conclusies ingediend voor aanvang van het onderzoek.

2. Met betrekking tot **nucleotide en/of aminozuur sequenties** die genoemd worden in de aanvraag en relevant zijn voor de uitvinding zoals beschreven in de conclusies, is dit onderzoek gedaan op basis van:

   a. type materiaal:

   ☐ sequentie opsomming

   ☐ tabel met betrekking tot de sequentie lijst

   b. vorm van het materiaal:

   ☐ op papier

   ☐ in elektronische vorm

   c. moment van indiening/aanlevering:

   ☐ opgenomen in de aanvraag zoals ingediend

   ☐ samen met de aanvraag elektronisch ingediend

   ☐ later aangeleverd voor het onderzoek

3. ☐ In geval er meer dan één versie of kopie van een sequentie opsomming of tabel met betrekking op een sequentie is ingediend of aangeleverd, zijn de benodigde verklaringen ingediend dat de informatie in de latere of additionele kopieën identiek is aan de aanvraag zoals ingediend of niet meer informatie bevatten dan de aanvraag zoals oorspronkelijk werd ingediend.

4. Overige opmerkingen:

Aanvraag nr.:

SCHRIFTELIJKE OPINIE

NL2008012

Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid

1. Verklaring

Nieuwheid	Ja:	Conclusies 5-9, 14-18
	Nee:	Conclusies 1-4, 10-13
Inventiviteit	Ja:	Conclusies 5, 6, 14, 15
	Nee:	Conclusies 1-4, 7-13, 16-18
Industriële toepasbaarheid	Ja:	Conclusies 1-18
	Nee:	Conclusies

2. Citaties en toelichting:

Zie aparte bladzijde

Reference is made to the following documents :

D1 DE 199 39 390 A1

D2 US 2009/226353 A1

D3 DE 25 24 861 A1

D4 US 2010/061906 A1

D5 Dr. Andrew M Dunster, "Flue gas desulphurisation (FGD) gypsum in plasterboard manufacture"

V. Reasoned statement regarding novelty and inventive step

1. The subject-matter of claim 1 lacks novelty because D1 (see col.1, lin.3-33) discloses a method for generating current from hydrogen sulphide-containing exhaust gases with the same features as the method of claim 1 :

   - the hydrogen sulphide-containing exhaust gases are delivered to a current generation device and are burnt there (gas engine), preferably with air being supplied,

   - the energy released during combustion being employed at least partially for current generation (see col.1, lin.28-33).

   D3 discloses the subject-matter of claim 1 too (see p.2, §2 - p.3, §2) ; whereby the generation of current by the gas turbine is considered as an implicit feature.

   The subject-matter of claims 4,10 ,13 is known from each of D1 and D3.

2. The subject-matter of claim 1 also lacks an inventive step with respect to D2 taken in combination with the general knowledge of the skilled person. D2 discloses the following features of claim 1 :

   - the hydrogen sulphide-containing exhaust gases are burnt with air (furnace 26),

   - the energy released during combustion is employed at least partially for the

generation of steam (waste heat boiler 28, see [0029]).

D2 does not provide information on the use of the steam generated by the waste heat boiler (28). For a skilled person it would be obvious, however, to generate electricity by routing the steam to a steam power cycle involving a steam turbine coupled to an electric generator.

The features introduced in claims 3 and 12 cannot be considered as involving an inventive step either, because they constitute standard components of a steam power cycle. The feature of claims 2 and 10 is known from D2 (see [0025]). The subject-matter of these claims does not involve an inventive step.

3. The subject-matter of claims 7,8 and 16,178 lacks an inventive step because it is rendered obvious by combination of documents D1 and D4 in combination with the general technical knowledge of the skilled person as exemplified by D5.

   The use of the energy generated by the combustion of hydrogen sulfide containing waste gas for covering the energy needs of the gypsum plant would be obvious for a skilled person. The subject-matter of claims 9,18 thus lacks inventive step.

4. The subject-matter of claims 5,6,14,15 is neither known from nor implied by the cited prior art. Hence the subject-matter of this claim appears to be novel and to involve an inventive step.