

Assembly for purifying toxic gases from production processes

The invention concerns an arrangement for purifying toxic gases from production processes by thermal conversion in a reactor chamber and the subsequent
5 treatment of the reaction products with a sorption agent in a washing equipment to bind water-soluble reaction products and flush out solid reaction products.

Such toxic gases occur in great quantities, for example, during the manufacture of semi-conductor circuits and due to their toxicity cannot be released untreated
10 to the environment. Such gases are, for example, HF, SiH₂Cl₂, SiCl₄, NH₃, C₂F₆, PH₃, BCl₃, NF₃, etc.

It is known that most of these waste gases from semi-conductor processes or also from other chemical processes can, as a rule, be rendered harmless by
15 oxidation or thermal conversion. As a rule, the thermal conversion is carried out in a flame, that is fed with natural gas or hydrogen and air or oxygen. No further reaction partners, with the exception of the possible additional oxygen or air, need to be supplied for this purpose. The thermally treated reaction products are completely harmless and are present either in gaseous or solid form or are water-
20 soluble. The gaseous reaction products, like steam or CO₂ can be passed into the environment without any further treatment.

It is understood, that for the thermal conversion a number of combustion processes and reaction chambers have already been developed and used in the
25 practice. Thus from EP 0 346 803 B1 an arrangement to purify waste gases is known, that comprises a reaction chamber, at the bottom of which a burner is provided, that is operated with fuel gases, like hydrogen and oxygen or air or natural gas and air on the one hand, and on the other the waste gas to be purified is fed to it. The reaction product occurring during combustion comprises solid
30 components as well as water-soluble reaction products.

To enable the complete removal of these reaction products from the waste gas, the reaction products resulting during the combustion are brought into contact with a sorption agent, for example water, immediately after the combustion. This

is carried out by providing a spraying device for water above the flame of the burner with the water being sprayed against the rising gas flow of the reaction products. At the same time the spraying device can be so constructed, that the sprayed sorption agent is not sprayed into the flame (EP 0 702 771 B1) or a
5 spray-protection device (sphere, spherical cup) is provided above the flame of the burner and the spraying device is arranged above this spray protection, as this can be seen from EP 0 346 803 B1.

The objective in this case is, to release the water-soluble reaction products from
10 the waste gas of the burner and to flush out the solid components (e.g. SiO_2 as reaction product of silane) from the reaction chamber. According to DE 196 00 873 A1 or also WO 03/085321 the reaction chamber is restricted upwards by a spray protection and radially by a cylindrical wall and the entire arrangement is enveloped by an external wall. At the same time the solid reaction products, with
15 the sorption agent, are flushed downward along the inside of the external wall, consequently outside the combustion chamber, and past the burner provided below to a processing plant.

In this case it is a particular disadvantage, that the combustion has to be carried
20 out at relatively high temperatures and consequently the components of the combustion chamber are also subjected to high temperatures and stresses caused by temperature changes and consequently wear relatively quickly. A further disadvantage is the fact, that due to the upward burning flame reaction products can settle in or on the burner. The result is a continuous deterioration of
25 the efficiency and the necessity of frequent cleanings.

The last disadvantage was eliminated to a great extent by that the burner jet was arranged at the top of the combustion chamber, as it becomes obvious from EP 0 803 042 B1, and consequently the flame points downward. Thus deposits of solid
30 reaction products on the burner were eliminated to a great extent and consequently a markedly improved service life is achieved. The problem of high temperature stress of the reaction chamber, however, remained. The consequences are considerable maintenance costs.

In the case of other waste gas purifying methods the work is carried out using an upward burning flame and a subsequent catalytic waste gas treatment (EP 0 736 322 B1). However, it has come to light that a final treatment with a sorption agent is useful and necessary.

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Embodiments of the invention seek to provide an arrangement for purifying toxic gases from production processes, that achieves the possibly most effective purification at a high gas flow rate and at the same time makes a very effective cooling of the reaction chamber possible.

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One aspect of the present invention provides an arrangement for purifying toxic gases from production processes by thermal conversion in a reactor chamber and the subsequent treatment of the reaction products with a sorption agent in a washing equipment to bind water-soluble reaction products and flush out solid reaction products, characterised in that the reactor chamber comprises an external and an internal wall, whereby the internal wall tapers downward with a funnel shape at a predetermined angle, that on the reactor chamber a device, that encloses the chamber on the top, is provided for the thermal treatment of the toxic gases, that the downward tapering internal wall of the reactor chamber on the inside has a film of water uniformly flowing downward, while the internal wall of the reactor chamber is surrounded on the outside by a water jacket and that at the bottom end of the tapering internal wall a waste gas outlet and a connection for water circulation is provided.

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In example embodiments, the reactor chamber comprises an external and an internal wall, whereby the internal wall tapers downward with a funnel shape at a predetermined angle, that on the reactor chamber a device, that encloses the chamber on the top, is provided for the thermal treatment of the toxic gases, that the downward tapering internal wall of the reactor chamber on the inside has a film of water uniformly flowing downward, while the internal wall of the reactor chamber is surrounded on the outside by a water jacket and that at the bottom end of the tapering internal wall a waste gas outlet and a connection for water circulation is provided.

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In one embodiment, the device for the thermal treatment of the toxic waste gases is a burner with a flame burning downwards, that burns downwards into the reactor chamber.

- 5 At the same time the burner is preferably an externally mixing burner with at least one central supply line for the toxic gases to be treated.

To achieve an as high as possible throughput of the toxic waste gases to be treated a plurality of supply lines are provided, while the jets for the fuel gas and
10 the jets for the air or oxygen surround the central supply lines for the toxic waste gases.

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In another embodiment, the device for the thermal treatment of toxic waste gases is an electrically heated chamber, while a plurality of supply lines are provided for the toxic waste gases to be thermally treated.

- 5 For the effective heating of the chamber a plurality of heating rods may be provided parallel to one another and protruding into the chamber, which may make a uniform heating of the volume of the chamber possible at least in the flow-through region of the toxic waste gases to be treated.
- 10 In another embodiment the external and internal walls are joined at the bottom with one another with a circular floor plate in such a manner, that the intermediate space between the internal wall and the external wall can be essentially fully filled with water, while the upper edge of the internal wall is constructed as an overflow for the water situated in the intermediate space and that the intermediate space is
- 15 connected to a water supply.

Either a regulating device or a throttle device may be allocated to the water supply for the water to be supplied to the intermediate space.

- 20 In example embodiments, that the waste gas outlet of the internal wall is connected to a washing tower provided next to the reactor chamber and filled with a filler to enable an effective post-treatment of the treated waste gases and in particular the removal of the water-soluble components from the waste gas of the reaction.

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In another embodiment, between the waste gas outlet and the washing tower a cooling device is provided for the thermally treated waste gas leaving the internal chamber, said cooling device comprising at least one spray nozzle for water.

- 30 The spray jet of the at least one spray nozzle is preferably directed against the direction of the gas flow.

In example embodiments, the water supply comprises a vertical pipe in the intermediate space, while the vertical pipe has a water outlet over the bottom plate of the intermediate space.

- 5 In order to achieve a redundancy two reactor chambers may be provided, the outlets of which can be coupled alternately with the washing tower and a water circulation.

10 Finally, provision is made to couple the connection for the water circulation of each reactor chamber with a water tank, that may be connected with a filter equipment for the solid reaction products and with a pump to fill the intermediate space.

15 The invention is explained in detail below based on an embodiment. The associated figures of the drawing show in:

Fig.1 - a schematic sectioned illustration of a reactor chamber with the burner placed on the top,

20 Fig.2 - an enlarged detail A of Fig.1,

Fig.3 - a schematic partially sectioned illustration of the open reactor chamber according to Fig.1, with water supply,

25 Fig.4 - a schematic sectioned illustration of a reactor chamber with an electrically heated reactor chamber, and

30 Fig.5 - a schematic illustration of an arrangement for purifying toxic gases from production processes with two reactor chambers coupled and an associated washing tower for the post-treatment of the thermally treated toxic gases.

Fig.1 shows a schematic sectioned illustration of an arrangement for purifying toxic gases from production processes with a reactor chamber 1 that comprises

an external and internal wall 2, 3. The internal wall 3 tapers downward with a funnel shape at a predetermined angle.

Along the inside of the downward tapering internal wall 3 of the reactor chamber 1 a uniform film 4 of water flows downward. This film of water is indicated in Fig.1 by a broken line. To achieve this, between the internal wall 3 of the reactor chamber 1 and the external wall 2 there is a water jacket in the intermediate space 5, to which a predetermined quantity of water is continuously supplied, so that the water supplied can run over the upper edge 6 of the internal wall 3 and form the film of water on the inside of the internal wall 3.

For this purpose the external and internal walls 2, 3 are joined together at the bottom with a circular floor plate 7 in such a manner, that the intermediate space 5 between the internal wall 3 and the external wall 2 can be basically fully filled with water, while the upper edge 6 of the internal wall 3 is constructed as an overflow for the water situated in the intermediate space 5 (Fig.2). The supply of the water into the intermediate space 5 is carried out via a vertical pipe 8, the outlet opening 9 of which is situated above the floor plate 7 (Fig.3). The vertical pipe 8 is connected to a water circulation 10, shown schematically in Fig.4. A regulating device for the incoming water may be allocated to the water supply to the vertical pipe 8; in the simplest case this regulating device may be a throttle device.

At the bottom end of the tapering internal wall 3 there is a waste gas outlet 11, that passes through the floor plate 7 and a connection 12, terminating in a water tank 13.

On the reactor chamber 1 a cover 14 is provided to enclose the combustion chamber 1, the cover 14 tightly joined with the top edge of the external wall 2, what can be carried out by means of a conventional snap closure. The cover 14 simultaneously serves the purpose of accommodating a burner 15 with the jets so directed towards the reactor chamber 1 that a flame, burning downwards into the reaction chamber 1, can be produced.

The burner 15 is preferably an externally mixing burner with a central supply line for the toxic waste gases to be treated. The supply of the waste gases to be treated is carried out via a plurality of supply lines 17, schematically indicated in Fig.1. The burner 15 is provided with jets for fuel gas, e.g. hydrogen or natural gas and with jets for air or oxygen. The corresponding fuel gas supply 18 to the burner is schematically illustrated in Fig.1. For the purpose of cleaning the burner opening within the reactor chamber 1 a cleaning device 19, that can be operated from the outside, with a scraper 20 is provided.

- 10 With the water jacket in the intermediate space 5 by and large an intensive cooling of the reactor chamber is achieved, so that all components, like the internal wall 3 and the external wall 2, are not subjected to a great thermal stress. Furthermore, the film 4 of water ensures on the inside of the internal wall 3 a strong dissipation of the radiated heat of the flame. At the same time the film 4 of water prevents deposits on the inside of the internal wall 3 and in the connection 12 for the water tank 13 and partly also at the waste gas outlet 11. For the ignition of the burner flame a pilot burner 21 is provided in the cover 14.

- 20 Instead of the burner 15 an electrically heated chamber 21 with a plurality of supply lines 22 for the toxic waste gases to be thermally treated can be placed on the reactor chamber 1 (Fig.4). In the chamber 21 there is a plurality of heating rods 23 provided parallel to one another and protruding into the chamber, which are fastened in the cover plate 25 of the chamber 21 by means of insulating bushings 24.

- 25 For the subsequent treatment of the reaction products with a sorption agent for the purpose of binding the water-soluble reaction products and flushing out the solid reaction products, a washing tower 26 is provided next to the reaction chamber 1. For this purpose the waste gas outlet 11 of the internal wall 3 is connected to the washing tower 26 (Fig.5).

In the washing tower 26 there is a filler material 27 and a plurality of spray nozzles 28, from which a sorption agent is sprayed.

For the cooling of the waste gases leaving the reactor chamber 1 a cooling device, in the form of at least one spray nozzle 34, the spray jet of which is directed against the direction of the gas flow, is situated between the waste gas outlet 11 and the washing tower 26.

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To achieve a certain redundancy of the arrangement according to the invention, two reactor chambers 1, 1' may be provided, their outlets 11 being able alternately connected with the washing tower 26 and the water tank 13 (Fig.5).

For this purpose throttle valves 29, 30 are provided in the supply lines.

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The connection 12 for the water circulation of each reactor chamber 1, 1' is connected with the water tank 13, that is coupled with a filter equipment 31 for the solid reaction products and with a pump 32 to fill the intermediate space 5. Furthermore, the water tank 13 can be filled via a water connection 33.

List of reference numerals

1. Reactor chamber
2. External wall
3. Internal wall
4. Film of water
5. Intermediate space
6. Edge
7. Floor plate
8. Vertical pipe
9. Outlet opening
10. Water circulation
11. Waste gas outlet
12. Connection for water tank
13. Water tank
14. Cover
15. Burner
16. Jet
17. Supply for toxic waste gases
18. Fuel gas supply
19. Cleaning device
20. Scraper
21. Scraper
22. Supply for toxic waste gases
23. Heating rod
24. Bushing
25. Cover plate
26. Washing tower
27. Filler
28. Spray nozzle
29. Throttle valve
30. Throttle valve
31. Filter equipment
32. Pump
33. Water connection
34. Spray nozzle

Patent claims

1. An arrangement for purifying toxic gases from production processes by thermal conversion in a reactor chamber and the subsequent treatment of the reaction products with a sorption agent in a washing equipment to bind water-soluble reaction products and flush out solid reaction products, characterised in that the reactor chamber comprises an external and an internal wall, whereby the internal wall tapers downward with a funnel shape at a predetermined angle, that on the reactor chamber a device, that encloses the chamber on the top, is provided for the thermal treatment of the toxic gases, that the downward tapering internal wall of the reactor chamber on the inside has a film of water uniformly flowing downward, while the internal wall of the reactor chamber is surrounded on the outside by a water jacket and that at the bottom end of the tapering internal wall a waste gas outlet and a connection for water circulation is provided.
2. An arrangement according to claim 1, characterised in that the device for the thermal treatment of the toxic waste gases is a burner with a flame burning downwards, that burns downwards into the reactor chamber.
3. An arrangement according to claim 2, characterised in that the burner is an externally mixing burner with at least one central supply line for the toxic gases to be treated.
4. An arrangement according to claim 3, characterised in that a plurality of supply lines are provided for the toxic waste gases to be treated, while the jets for the fuel gas and the jets for the air or oxygen surround the central supply lines.
5. An arrangement according to claim 1, characterised in that the device for the thermal treatment of toxic waste gases is an electrically heated chamber, while a plurality of supply lines are provided for the toxic waste gases to be thermally treated.

6. An arrangement according to claim 5, characterised in that the chamber can be heated by a plurality of heating rods arranged parallel to one another and protruding into the chamber.
- 5 7. An arrangement according to any one of the preceding claims, characterised in that the external and internal walls are joined at the bottom with one another with a circular floor plate in such a manner, that the intermediate space between the internal wall and the external wall can be essentially fully filled with water, while the upper edge of the internal wall is constructed as an overflow for the
10 water situated in the intermediate space and that the intermediate space is connected to a water supply.
8. An arrangement according to claim 7, characterised in that a regulating device is allocated to the water supply for the water to be supplied to the intermediate
15 space.
9. An arrangement according to claim 7, characterised in that a throttle device is allocated to the water supply for the water to be supplied.
- 20 10. An arrangement according to any one of claims 1 to 9, characterised in that the waste gas outlet is connected to a washing tower provided next to the reactor chamber.
11. An arrangement according to claim 10, characterised in that between the
25 waste gas outlet and the washing tower a cooling device is provided for the thermally treated waste gas leaving the internal chamber.
12. An arrangement according to claim 11, characterised in that the cooling device comprises at least one spray nozzle for water.
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13. An arrangement according to claim 12, characterised in that the spray jet of the at least one spray nozzle is directed against the direction of the gas flow.

14. An arrangement according to any one of claims 1 to 13, characterised in that the water supply for the intermediate space comprises a vertical pipe, that has a water outlet over the bottom plate.
- 5 15. An arrangement according to any one of claims 1 to 14, characterised in that two reactor chambers are provided, the outlets of which can be coupled alternately with the washing tower and a water circulation.
- 10 16. An arrangement according to any one of claims 1 to 15, characterised in that the connection for the water circulation of each reactor chamber is connected with a water tank, that is connected with a filter equipment for the solid reaction products and with a pump to fill the intermediate space.