

DESCRIPTION

The invention relates to an adsorption medium reactor, in particular moving bed reactor, and comprises two substantially vertical walls permeable by fluid. In particular, the invention relates to a wall component which is permeable by fluid and suitable for use as at least one wall in the adsorption medium reactor.

Adsorption medium reactors with a continuously or quasi-continuously moving bed of a granular adsorbent are used to increasing extent for waste gas purification. Certain fluid flow lengths and thereby certain reactor cross-sections are needed for the waste gas purification. To the extent that the waste gas to be purified contains highly toxic harmful substances, for example dioxines, furans or heavy metals, these are however already separated adsorptively in a relatively thin vertical entry layer of the moving bed column. In conventional reactors without vertical subdivision, the entire quantity of the adsorption medium disposed in the reactor must be removed after the discharge has special waste, for example be burnt at 1,200°C and a dwell time of at least two seconds. This disposal is extremely expensive.

A moving bed reactor, in which - in addition to metal guide plate louvres at the entry side and the exit side - a second row of metal relief plates is installed in the reactor, which plates are arranged substantially parallelly to the inward sides of the metal guide plates, is known from the DE-C 19 46 457. The metal relief plates take up a part of the static lateral pressure of the downwardly flowing adsorbent and have the effect that the adsorbent can be relieved of lateral pressure between two metal guide plates and unite with the main flow of the adsorbent in the centre of the moving bed.

The moving bed reactor of the kind according to the species, in which two adsorption medium layers are formed in the reactor bed and each separated from the other by walls permeable by gas, is furthermore known from the DE-A 26 26 939. The known walls permeable by gas are either perforated plates or formed as louvre constructions sloping in opposite sense. They serve for variation of the passage speed of the fluid and are to represent a compromise solution between as extensive as possible a

loading of the entire adsorbent on the one hand and an adequate purification of the waste gas on the other hand. A reliable separation into toxically highly loaded or little loaded adsorption medium layer is neither envisaged nor readily possible in this known construction.

Perforated plates were used hitherto for the reliable subdivision of a moving bed into two or more vertical layers of different harmful substance loading. In that case, relatively large openings had to be provided in the partition walls in order to reduce the danger of rapid flogging, increases in flow resistance and non-uniform fluid distribution over the fluidised bed body. Known walls of that kind however have the disadvantage that no exact particle separation could be achieved between the neighbouring vertical layers. Known louver walls sloping in opposite sense (DE-A-26 26 939) have an appreciable space requirement in the interior reactor space and cause relatively large heaps of pourable material, which make the flow resistance non-uniform over the height of the reactor.

It is the object of the invention to achieve the prerequisites for a simple, exactly definable separation between two vertical layers with reliable prevention of a particle crossing-over and without appreciable impairment of the fluid flows.

According to the invention, this problem is solved by a wall component permeable by fluid according to the patent claim 1.

The wall component permeable by fluid is suitable as pourable material boundary wall at an outward reactor side as well as also as pourable material partition wall between two chambers of a reactor.

In the new adsorption medium reactor, in particular moving bed reactor, at least one wall consists of the wall component according to the invention, the gap sieve of which is arranged at the inflow side and provided with gap boundary elements extending downwardly from above, wherein the width of the gap is so matched to the grain size of the pourable material that the solid substance particles except for fine-grained particles are held back in the leading part of the treatment chamber and wherein the louver construction with the laminae extending transversely to the gap-bounding elements is arranged at the trailing side of the stabilising grid.

The combination, which is provided according to the invention, of a gap sieve extending over the entire boundary wall with the stabilising grid has decisive constructional and functional advantages in an adsorption medium reactor: the gap sieve forms a practically smooth area, which is free of disturbing locations and at which the particle flow of the adsorption medium can flow downwardly from above in substantially one plane. Particles of normal size are held back by the boundary wall at the leading side. The fluid flow is thereagainst let through practically unhindered over the entire height of the boundary wall. The crossing arrangement of the gap-bounding elements, of the stabilising grid and of the laminae assures an extremely high shape stability, stiffness and rigidity so that the properties and the shape of the boundary wall do not change even when the loadings at both sides of the boundary wall fluctuate greatly (for example due to selective charging or discharging of the adsorption medium at both sides of a partition wall).

A further increase in the rigidity of the boundary wall lets itself be achieved in development of the invention thereby, that the stabilising grid on the trailing side displays several band profiles, which cross the connecting elements, wherein the flat sides of the band profiles extend downwardly from above and substantially parallelly to the fluid flow direction.

According to the arrangement of the louvre construction at an outer boundary wall or at a partition wall disposed in the reactor itself, the louvre laminae preferably at different directions of slope. In association with a reactor exit wall, the louvre laminae have above all the task of collecting fine-grained particles, that have passed through the gap-bounding elements, and as far as possible conduct them away directly into a discharge equipment. In this function, the laminae, starting out from the band profiles, are inclined obliquely upwards and namely preferably at an angle of about 25 to 35° to the vertical plane.

In association with a partition wall, the laminae of the louvre construction thereagainst have a downward slope. A slope angle of 15 to 25°, in particular about 20° to the vertical has proved to be favourable, since the advantages of a reliable deflection of the particle flow on the exit side of the partition wall and a relatively low wall thickness and compact mode of construction are combined by this angle of slope.

The use of a gap sieve, which extends over the entire trailing exit cross-section of the reactor, in connection with the stabilising grid and approximately vertically extending band profiles has two decisive advantages: On the one hand, only fine-grained particles get out of the reactor chamber into the region of the louvre construction so that the tendency to heap up is reduced decisively; on the other hand, the vertically extending, spaced band profiles in the stabilising grid take care of a problem-free discharge of the fine-grained particles of the pourable material downwardly, since they bound vertically continuous channels or shafts between the gap sieve on the one hand and the louvre construction consisting of inclined laminae on the other hand. The opening cross-section for the fluid remains uniformly distributed over the entire height of the wall at the exit side; this does not change also with progressive reactor operation. Heaped accumulations, which in all known constructions are the cause of more or less strong non-uniformities in the flow resistance and have thus been in the flow profile of the fluid, are practically no longer there.

As partition wall, the wall component according to the invention creates the prerequisite for the adsorption medium flows into both the vertical chambers being capable of different speeds at both sides of the wall.

The vertical layer, which is at the entry side and to be discharged as special waste, can be loaded to a large extent before its discharge. The at least one further vertical layer adjoining thereat in the main body of the adsorption medium bed can then be discharged either continuously or charge by charge according to a completely different cycle. This layer, which is largely free of highly toxic trace elements, can be discharged by relatively simple means, prepared again or be burnt in normal combustion plants in correspondingly cheap manner.

The thickness and the cross-section of the individual chambers and thereby the position of the partition walls are selectable in adaptation to certain content materials or harmful substances in the fluid and with a view to a desired behaviour of separation. In particular, several partition walls can be installed in the reactor in such a manner that the cross-flowing fluid flows through at least two partitions and three

chambers one after the other. Different filling stocks (for example more or less strongly effective adsorption media) with equal or different filling states can also be inserted into the individual chambers separated by partition walls. The invention is therefore usable with in principle the same advantages independently of the cross-flow medium that is used and the adsorption medium flows.

The spacing of the at least one partition wall from the fluid exit wall is preferably several times greater than that from the fluid entry wall. This has the advantage that the leading vertical chamber has relatively small dimensions and the layer volume can be minimised to the size sufficient for the adsorption of the volatile highly toxic substances.

The wall component according to the invention can come into use with the described advantages in an adsorption medium reactor as boundary wall at the fluid exit side of the reactor as well as also as at least one partition wall. On the other hand, the boundary wall at the exit side can however also be used in a reactor which is not subdivided and - conversely - one or more partition walls of the kind according to the invention can be used in conjunction with an otherwise conventional reactor.

Advantageous developments of the invention are characterised in the subclaims.

The invention is explained more closely in the following with the aid of examples of embodiment illustrated schematically in the drawing. In the drawing, there show:

Figure 1 a schematic vertical section through a part of a moving bed reactor with partition and boundary walls constructed according to the invention,

Figure 2 an horizontal section through a part of a wall component according to the invention, i.e. a partition wall or a part of the reactor exit wall according to Figure 1 with a gap base of a gap sieve, a stabilising grid and a louvre construction (section II-II in Figure 1),

Figure 3 a sectional view, which is reduced in scale by comparison with Figure 2, through a part of the partition wall,

- Figure 4 a sectional view according to Figure 3 through a part of the reactor exit wall according to Figure 1,
- Figure 5 a gap base modified by comparison with the embodiment according to Figure 4 and
- Figure 6 a further modified embodiment of a gap base arrangement as can find use at the exit wall of the reactor as well as also in the partition wall.

Figure 1 shows a schematic vertical section through a part of an example of embodiment of the adsorption medium reactor 1, which is called "adsorber" in the following. The adsorber 1 has a rectangular cross-section in the described example of embodiment. It comprises a reaction container 2, which bounds a treatment chamber 3. A charging base with charging funnels arranged in the manner of a matrix for the uniform distribution of the pourable material over the cross-section of the treatment chamber 3 and a discharge base 6 and 6a with several discharge funnels for the discharge of the pourable material out of the treatment chamber 3 are provided in the reaction container 2.

A substantially vertically extending partition wall 7 divides the treatment chamber 3 into two chambers 3a and 3b. The chamber 3a faces the entry venetian blind 9 and the chamber 3b extends from the outflow side of the partition wall 9 to the opposite reactor exit wall 8.

The fluid to be treated - flue gas in the example of embodiment - flows through the adsorber 1 in the manner illustrated by lines or arrows. The flue gas enters into the adsorber 1 at the bottom, flows around the discharge base 6 with the discharge funnels and the discharge nipples and enters through a gas inlet box and the entry venetian blind 9 over the largest part of the overall height of the reaction container 2 into the treatment chamber 3a at the inflow side. The setting angle of the metal plates forming the inlet louvre blind 9 amounts to $70^{\circ} \pm 5^{\circ}$ to the horizontal in the described example of embodiment. The bed in the treatment chamber is flowed through in transverse directions as the flow lines show. The fluid issues at the outflow side through the exit wall 8 and the louvre construction 10 into a gas outlet box. The louvre

construction 10 at the exit side displays laminae which are arranged vertically one above the other and in the described example of embodiment are set at an angle of $60^\circ \pm 5^\circ$, preferably 60° to 65° , to the horizontal.

The aspects, which are new according to the invention, relate above all to the structure of the partition wall 7, which in the described example of embodiment extends vertically, and the quite similarly structured exit wall 8 of the reaction container 2. These new aspects shall be explained more closely in the following with the aid of the schematic partial views according to the Figures 2 to 4.

As is shown above all by the enlarged horizontal sectional view according to Figure 2, the partition wall 7 or the wall 8 is constructed as gap base. The latter consists of a leading gap sieve 13 with rod-shaped gap-bounding elements 13a, which extend downwardly from above and are of uniform triangular cross-section. The gap sieve 13 is connected in the manner of a sandwich with a stabilising grid 14. For usual grain size of the active carbon used as adsorption medium, the gap-bounding elements 13a have a gap width of 1.25 millimetres $\pm$ 0.5 millimetres, a profile side length facing the active carbon bed of 2.2 millimetres $\pm$ 0.5 millimetres and a depth towards the stabilising grid of 4.5 millimetres $\pm$ 1 millimetre. These dimensions however correspond only to an example of embodiment realised in a prototype; the width of the gap 13b between two neighbouring gap-bounding elements 13a in particular is expediently dependent on the size of the pourable material particles which are to be held back by the gap sieve in the treatment chamber 3a at the entry side (or in the case of the exit wall 8, in the treatment chamber 3b at the exit side).

The stabilising grid consists according to Figure 2 of connecting rods 15, which extend transversely to the gap-bounding elements 13a, as well as of band profiles 16 arranged at a greater spacing parallelly to the gap-bounding elements. The longitudinally extending rod-shaped gap-bounding elements 13a are spot-welded to the connecting rods 15 arranged one above the other at a greater spacing; on the other side, the band profiles 16 are welded to the transversely extending connecting rods 15. Optionally, the narrow sides remote from the connecting rods 15 can be connected with, in particular welded to turned four-cornered rods 18 in the manner illustrated in Figure 2. These four-cornered rods are commercially

obtainable as assembly with the band profiles 16 (for other purposes) and are therefore also used here. The four-cornered rods 18 can also be provided in place of the rectangular or round connecting rods 15.

As stated above, the exit wall 8 of the reaction chamber 3 in the described example of embodiment is provided with the same, about vertically extending gap base 12 as well as the partition wall 7. To that extent, pourable material is held back on the inflow side at the gap bases 12 of both walls 7 and 8 at least to the extent that its particle diameter is greater than the gap width 13b of the gap sieve 13. Insofar as fine-grained particles can penetrate through the gaps 13b in fluid throughflow direction (arrow A in Figure 2), they reach vertical channels 17 formed between the flat sides of the profiles 16 and fall through these (continuous) channels downwardly into a discharge region which is denoted by 19 for the exit wall in Figure 4. In the discharge region, these fine-grained particles are either fed again to the neighbouring discharge funnel of the discharge base 6 or also in a given case discharged separately in order continuously to reduce the technologically unfavourable dust components.

Other than for conventional cross-flow adsorbers, no appreciable heaps of pourable material form on the inclined louvre laminae 10 at the exit side of the reaction container 2 so that the fluid needs a uniform flow resistance at the outflow side over the entire height of the reaction container. To that extent, the angle of slope of the individual metal lamination plates 10 of the venetian blind is also uncritical; preferably, the angle of slope is however sufficiently great in order to let pourable material impinging on the laminae 10 to be fed back or flow away into the channels 17. For this purpose, an angle of about $60^\circ \pm 5^\circ$ to the horizontal plane has proved to be expedient for the laminae 10.

For a construction of the gap bases of the walls 7 and 8, which agrees for the remainder, the partition wall 7 has a different arrangement of the louvre laminae 20 at the outflow side facing the chamber 3b. The laminae 20 are arranged to be sloping obliquely downwards from the gap base 20 and in the direction of the chamber 3b. An angle of slope to the vertical of $20^\circ \pm 5^\circ$ has proved to be favourable in order on the one hand to assure a relatively free passage of fluid and on the other hand reliably

to prevent a passing-over of pourable material from the chamber 3b into the chamber 3a at the entry side. With the acute angle to the vertical, the space requirement of the wall 7 inclusive of the laminae 20 is also still acceptably low in the reactor.

As is to be seen, the columns of pourable material in the chambers 3a and 3b, which are separated each from the other by the wall 7, are continuously separated one from the other as far as into the discharge region individually associated with each of them. In particular, the chamber 3a at the entry side receiving the layer at the entry side has individual discharge funnels 6a. The larger particles issuing out of the chamber 3a through the gap-bounding elements 13a on entry into the space between the band profiles 16 fall vertically downwards through the channels 17 and are conducted away by the wall 19' into the discharge funnel 6a. A passing-over of these laden particles into the chamber 3b is prevented. The adsorption medium column disposed in the relatively narrow chamber 3a can be emptied by way of the discharge 6a independently of the main bed in the chamber 3b and fed to the suitable removal, for example as special waste, to a combustion plant. According to experience, almost all highly toxic components, such as dioxines and furans, are separated adsorptively in this relatively thin layer. After passage through the partition 7, the other harmful substances are separated adsorptively on a travel path, which is for example nine times greater, of the fluid in the adjoining chamber 3b, near to the exit. The discharge of the consumed or laden adsorption medium out of the chamber 3b is comparatively simple and possible free of problems. This adsorption medium can in a given case also be regenerated and fed back into the reaction container 2.

A continuous formation of the gap-bounding elements 13a as well as also of the band profiles 16, which extend parallelly with these (at a substantially greater spacing) is to be preferred as a rule also for reasons of costs. On the other hand, these vertically extending components 13a and 16 can however also be assembled from several parts either by butt joint or with tothing or overlapping. It suffices in particular for the band profiles 16 when they extend over a partial length of the reactor height in such a manner that the laminae of the venetian blind 10 can be fastened at, in particular be welded to them. An interruption of the band

profiles 16 is without significance for the reliable discharge of the fine-grained particles through the channel portions 17, since a particle exchange between adjacent channels 17 does not impair the particle conduction downwardly from above and also the inclined laminae 10 have a directional effect obliquely downwards.

The Figures 5 and 6 show embodiments of gap bases 40 and 50, in which the gap sieve each time consists of several vertical portions 41a and 41b or 51a to 51c, which are arranged to be overlapping. In the embodiment according to Figure 5, each gap sieve portion is bent over twice at its upper end 42 and engages behind the lower end of the higher gap sieve portion 41a. The individual gap-bounding rods are arranged vertically one with the other in the overlapping gap sieve portions 41a and 41b. A stabilising grid 44 with transversely extending connecting rods 45 and with band profiles 46 bounding discharge channels 17 is also provided in the modified embodiment according to Figure 5. The band profiles 46 are however interrupted vertically and associated only with the planar parts of the gap set portions 41a and 41b, respectively. The venetian blind laminae connected with the band profiles 46 are not illustrated in the Figures 5 and 6.

In the embodiment in Figure 5, the vertical boundary plane of the pourable material bed is interrupted in the overlapping region of the gap sieve portions 41a and 41b. A small heap 47 forms there. Because of the free space in the region of the overlapping place on the other side of the heap 47, the increase in the flow resistance there is of no importance. The interruption of the gap-bounding elements or of the gaps 13b formed between these however has the advantage that pourable material particles, in particular elongate ones, which are caught in the gaps 13b, come free of the gap guide in sections, namely in the region of the heap 47, and can re-orient themselves.

A similar effect is achieved in the modified embodiment illustrated in Figure 6. The effective gap-bounding elements in the gap sieve portions 51a to 51c extend predominantly sloping somewhat to the generally vertical direction of movement of the pourable material in the treatment chamber 3. Because of the oblique inclination of the gap sieve portions, only one offset is provided in the overlapping region 52 in the case of the embodiment according to Figure 6.

A stabilising grid is individually associated with each of the gap sieve portions 51a to 51c also in the case of the embodiment according to Figure 6. Only the transversely extending connecting rods 55 are illustrated in Figure 6.

Numerous modifications are possible within the scope of the inventive idea. Thus, the components belonging individually to the gap base 12 can have predominantly rounded-off edges and large spacings and/or small wall thicknesses subject to consideration of the stabilisation requirements. The outflow side can in a given case also be formed to be curved horizontally or polygonally and planar in sections. The construction of the venetian blind is not critical because of the special supporting and retaining function of the gap base 12, 40 or 50. The size of the channel should as far as possible be so chosen that, on the one hand, the space requirement is low and, on the other hand, a reliable discharge of the pourable material particles penetrating the gap sieve under the influence of gravitational force is assured.



CLAIMS

1. Wall component (7, 8) permeable by liquid, in sandwich like construction and comprising a wedge-wire screen (13) with substantially parallelly extending gap-bounding elements (13a) and a stabilising grid (14), which comprises connecting elements (15), which extend transversely to the gap-bounding elements, and a venetian blind construction with louvres (10, 20), which extend transversely to the gap-bounding elements.
2. Wall component according to claim 1, characterised thereby, that the stabilising grid (14; 44) comprises several tie profiles (16; 46), which cross the connecting elements (15; 45; 55).
3. Wall component according to claim 1 or 2, characterised thereby, that the gap-bounding elements (13a) have about triangular cross-sectional profiles, the one side of which forms the bounding surface of the wall and the opposite corner of which is supported at transversely extending connecting elements (15) of the stabilising grid (14).
4. Wall component according to one of the claims 1 to 3, characterised thereby, that the gap-bounding elements (13a), the transversely extending connecting elements (15), the tie profiles (16) and the inward edges of venetian blind louvres (10; 20), which are arranged one above the other, are arranged to be crossing substantially at right angles in alternation.
5. Wall component according to one of the claims 1 to 4, characterised thereby, that the gap-bounding elements (13a) are spot-welded to the transversely extending connecting elements (15).
6. Wall component according to one of the claims 1 to 5, characterised thereby, that a substantially vertical channel (17) for the discharge of small-grained particles, which have passed through the wedge-wire screen, is provided between each two neighbouring tie profiles (16) of the stabilising grid (14).



7. Wall component according to one of the claims 1 to 6, characterised thereby, that the louvres (10; 20) of the venetian blind construction are arranged to be inclined to the rod-shaped gap-bounding elements.

8. Adsorption medium reactor, in particular moving bed reactor, which is flowed through in cross-current by the fluid to be treated and comprises two substantially vertical walls permeable by fluid, wherein at least one wall consists of a wall component according to one of the claims 1 to 7, the wedge-wire screen (13; 41, 51) of which is arranged at the leading side and provided with gap-bounding elements (13a) extending downwardly from above, wherein the width of the gap (13b) is so matched to the grain size range of the pourable stock that the solid substance particles except for fine-grained particles are held back in the leading part of the treatment chamber (3, 3a) and wherein the venetian blind construction with the louvres (10; 20), which extend transversely to the gap-bounding elements, is arranged at the trailing side of the stabilising grid (14; 44).

9. Reactor according to claim 8, characterised thereby, that the flat sides of the tie profiles (16; 46), which cross the connecting elements (15; 45; 55), extend downwardly from above and substantially parallelly to the fluid flow direction (A).

10. Reactor according to claim 8 or 9, characterised thereby, that the gap-bounding elements (13a) have about triangular cross-sectional profiles, the one side of which is flowed towards by the fluid and the corner of which lying opposite to the leading side is connected with the transversely extending connecting elements (15; 45; 55) of the stabilising grid (14; 44).

11. Reactor according to claim 9 or 10, characterised thereby, that a substantially vertical channel (17) for the discharge of small-grained particles, which have passed through the wedge-wire screen, is provided between each two neighbouring tie profiles (16) of the stabilising grid (14).



- 14 -

12. Reactor according to claim 11, characterised thereby, that the channels (17) formed between the tie profiles (16) open out into a discharge funnel at the lower end.

13. Reactor according to one of the claims 8 to 12, characterised thereby, that the gap-bounding elements (13a) are constructed as straight rods.

14. Reactor according to one of the claims 8 to 13, characterised thereby, that the wedge-wire screen (4', 5') consists of several vertical portions (41a, 41b; 51a to 51c), which are arranged to be overlapping in such a manner that the respectively higher wedge-wire screen portion (41a; 51a) overlaps the lower portion (41b, 51b) towards the treatment chamber (3).

15. Reactor according to claim 14, characterised thereby, that the upper end (42; 52) of each wedge-wire screen portion (41a, 41b; 51a to 51c) is cranked.

16. Reactor according to claim 14 or 15, characterised thereby, that the individual gap-bounding elements (13a) of each wedge-wire screen portion (41a; 51a) are aligned with those of the neighbouring wedge-wire screen portions (41b; 51b).

17. Reactor according to claim 15 or 16, characterised thereby, that each wedge-wire screen portion (41a, 41b) is associated with individual stabilising grid (44), which is connected with a planar region of the wedge-wire screen portion.

18. Reactor according to one of the claims 8 to 17, characterised thereby, that the wedge-wire screen (13) of a wall (8), which is permeable by fluid, bounds the reactor bed (3) on the fluid exit side.

19. Reactor according to claim 18, characterised thereby, that the venetian blind construction comprises louvres (10), which are arranged to be inclined obliquely upwards.



20. Reactor according to claim 19, characterised thereby, that the venetian blind louvres (10) are arranged to be inclined at an angle between 25° and 35° to the vertical.

21. Reactor according to the claims 11 and 19 or 20, characterised thereby, that the louvres (10) of the venetian blind construction are arranged to be inclined to the vertical channels (17) in such a manner that the pourable stock on the louvres is steered into the channels under the influence of gravitational force.

22. Reactor according to one of the claims 8 to 21, characterised thereby, that the reactor bed is subdivided into chambers (3a, 3b) by at least one substantially vertical wall (7), which is permeable by fluid, and that a venetian blind construction with louvres (20), which are inclined obliquely downwards, is provided at the trailing side of the stabilising grid (14) connected with the wedge-wire screen (13).

23. Reactor according to claim 22, characterised thereby, that the venetian blind louvres (20) are arranged to be inclined at an angle between 15° and 25° to the vertical.

24. Reactor according to claim 22 or 23, characterised thereby, that the chambers (3a, 3b) separated by the subdividing wall (7) are associated with separate adsorption medium discharge equipments (6a, 6), by which the bed columns in the chambers are selectively dischargeable and adjustable.

25. Wall component according to one of the claims 22 to 24, characterised thereby, that the spacing of the at least one subdividing wall (7) from the fluid exit wall (8) is several times greater than that from the fluid entry wall (9).