DEHUMIDIFIER AND PHOTOIONIZATION DETECTING DEVICE WITH DEHUMIDIFYING FUNCTION

BACKGROUND

Technical Field

[0001] The instant disclosure is related to a dehumidifying technology applicable to a photoionization detecting device, in particular, to a dehumidifier and a photoionization detecting device with dehumidifying function.

Related Art

[0002] Along with the developments of industries, different materials and products are developed; however, more and more toxic/hazardous substances are also generated. One of the substances is volatile organic compounds (VOC). Hence, it is necessary to detect the VOC. For example, the VOC in a certain environment is detected to determine the safety level of the environment.

[0003] A VOC detecting method known to the inventor is to break the gas sample molecules into charged ions by photoionization device (PID), so that the concentration of the VOC can be calculated according to the generated current intensity. However, when water content in the gas sample is too much, the sensitivity of the PID will be affected.

SUMMARY

[0004] In view of this, an embodiment of the instant disclosure provides a photoionization detecting device with dehumidifying function. The device comprises a photoionization detector and a dehumidifier. The photoionization detector has a gas inlet. The dehumidifier comprises an outer housing, a dehumidifying tubing, and a humidity absorbent. An interior of the outer housing has a receiving room. The outer housing comprises an inlet, an outlet, and a drain valve structure. The outlet is connected to the

gas inlet of the photoionization detector, and the drain valve structure is configured at a lowest position of the outer housing. The dehumidifying tubing is received in the receiving room, and the dehumidifying tubing is connected between the inlet and the outlet of the inside of the outer housing. The humidity absorbent is received in the receiving room, and the humidity absorbent is located between the dehumidifying tubing and the drain valve structure.

[0005] In one or some embodiments, the dehumidifier further comprises a cartridge, the cartridge is received in the receiving room of the outer housing, and the cartridge receives the humidity absorbent. Furthermore, the cartridge is a replaceable cassette cartridge. Moreover, the dehumidifier may further comprise a cartridge holder, the cartridge holder is received in the receiving room of the outer housing, and the cartridge holder fixes and supports the cartridge.

[0006] In one or some embodiments, the cartridge comprises a plurality of ventilation holes or the cartridge is of porous property.

[0007] In one or some embodiments, the outer housing of the dehumidifier comprises an upper case, a lower case, and a detachable structure, the detachable structure is adapted to assemble the upper case and the lower case with each other being detachable. Moreover, the detachable structure is a screw thread structure, an elastic engagement structure, or a male-female buckling structure. Furthermore, the outer housing may further comprise a seal ring sandwiched between the upper case and the lower case.

[0008] In one or some embodiments, the drain valve structure comprises a drain hole, a seal gasket, a metal washer, a fixing nut, and a drain screw, the drain screw selectively opens or closes the drain hole.

[0009] In one or some embodiments, the photoionization detecting device further comprises a filter adaptor unit connected between the outer housing and the

photoionization detector.

[0010] In one or some embodiments, the humidity absorbent is selected from a group consisting of magnesium chloride, lithium chloride, and sodium silicate.

[0011] Another embodiment of the instant disclosure provides a dehumidifier. The dehumidifier comprises an outer housing, a dehumidifying tubing, and a humidity absorbent. An interior of the outer housing has a receiving room. The outer housing comprises an inlet, an outlet, and a drain valve structure. The drain valve structure is configured at a lowest position of the outer housing. The dehumidifying tubing is received in the receiving room. The dehumidifying tubing is connected between the inlet and the outlet of the inside of the outer housing. The humidity absorbent is received in the receiving room and located between the dehumidifying tubing and the drain valve structure.

[0012] In one or some embodiments, the dehumidifier further comprises a cartridge, the cartridge is received in the receiving room of the outer housing, and the cartridge receives the humidity absorbent; wherein the cartridge is a replaceable cassette cartridge.

[0013] In one or some embodiments, the dehumidifier further comprises a cartridge holder, wherein the cartridge holder is received in the receiving room of the outer housing, and the cartridge holder fixes and supports the cartridge.

[0014] In one or some embodiments, the cartridge comprises a plurality of ventilation holes or the cartridge is of porous property.

[0015] In one or some embodiments, the outer housing of the dehumidifier comprises an upper case, a lower case, and a detachable structure, the detachable structure is adapted to assemble the upper case and the lower case with each other being detachable. Moreover, the detachable structure is a screw thread structure, an elastic engagement structure, or a male-female buckling structure. Furthermore, the outer housing may

further comprise a seal ring sandwiched between the upper case and the lower case.

[0016] In one or some embodiments, the drain valve structure comprises a drain hole, a seal gasket, a metal washer, a fixing nut, and a drain screw, the drain screw selectively opens or closes the drain hole.

[0017] As above, according to one or some embodiments of the instant disclosure, the dehumidifying tubing of the dehumidifier can be provided for releasing an amount of the water in the gas sample into the receiving room, and the gas sample with reduced relative humidity is more suitable for the measurement of compounds in low concentration or for the measurement of volatile organic compounds from the gas samples. Moreover, in one or some embodiments, the dehumidifier may further comprise a cartridge, and the cartridge may be a replaceable cartridge. Therefore, when the humidity absorbent in the dehumidifier is to be replaced, the user does not need to replace the entire dehumidifier; instead, the user can just replace the cartridge and the humidity absorbent received in the cartridge. Hence, the repair and maintenance of the dehumidifier can be achieved conveniently and the costs for the repair and maintenance of the dehumidifier can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The disclosure will become more fully understood from the detailed description given herein below for illustration only, and thus not limitative of the disclosure, wherein:

Fig. 1 illustrates a perspective view of a photoionization detecting device with dehumidifying function according to a first embodiment of the instant disclosure;

Fig. 2 illustrates an exploded view of the photoionization detecting device with dehumidifying function of the first embodiment;

Fig. 3 illustrates a partial sectional view of the photoionization detecting device with dehumidifying function of the first embodiment;

Fig. 4 illustrates a schematic operational view of the photoionization detecting device with dehumidifying function of the first embodiment;

Fig. 5 illustrates a partial sectional view of a photoionization detecting device with dehumidifying function according to a second embodiment of the instant disclosure; and

Fig. 6 illustrates an experimental graph showing the relative humidity of a gas sample processed with the dehumidifier and without the dehumidifier.

DETAILED DESCRIPTION

[0019] Fig. 1 illustrates a perspective view of a photoionization detecting device with dehumidifying function according to a first embodiment of the instant disclosure. Fig. 2 illustrates an exploded view of the photoionization detecting device with dehumidifying function of the first embodiment. Please refer to Figs. 1 and 2. In this embodiment, a photoionization detecting device with dehumidifying function (hereinafter, for the sake of convenience, photoionization detecting device 1 or PID device 1), comprises a photoionization detector (hereinafter, for the sake of convenience, detector 10) and a dehumidifier 20. The dehumidifier 20 is connected to the detector 10. The PID device 1 is applicable for detecting volatile organic compounds (VOC) or compounds in low concentration from gas samples. In the PID device 1, vacuum ultraviolet rays generated by inert gases during vacuum discharge are utilized to break gas sample molecules into charged ions. Hence, the concentration of a certain organic compound in the gas sample can be calculated using the current intensity generated by the ionized molecules. As shown in Figs. 1 and 2, the detector 10 has a gas inlet 101 for the gas sample to enter into the detector 10 from the dehumidifier 20. Therefore, before the gas sample enters into the detector 10, the water content in the gas sample can be reduced using the dehumidifier 20, thereby improving the sensitivity of the detector 10.

[0020] Please refer to Figs. 1 and 2. In this embodiment, the PID device 1 further comprises a filter adaptor unit 30 for connecting the detector 10 with the dehumidifier 20. In this embodiment, the filter adaptor unit 30 is connected between the outlet 213 of the dehumidifier 20 and the gas inlet 101 of the detector 10. The filter adaptor unit 30 allows the detector 10 to be connected with other components; detailed descriptions are provided as below. Furthermore, in some embodiments, the PID device 1 may be devoid of the filter adaptor unit 30. In other words, the detector 10 is directly connected to the dehumidifier 20, so that the gas inlet 101 of the detector 10 is in communication with the outlet 213 of the dehumidifier 20 directly.

[0021] Fig. 3 illustrates a partial sectional view of the PID device of the first embodiment. As shown in Fig. 3, the dehumidifier 20 comprises an outer cover 21, a ~~Nafion~~ dehumidifier tubing 22, and a humidity absorbent 23. An interior of the outer housing 21 has a receiving room 211 (closed chamber). The outer housing 21 comprises an inlet 212, an outlet 213, and a drain valve structure 24. The outlet 213 is connected to the gas inlet 101, and the drain valve structure 24 is configured at a lowest position of the outer housing 21. The dehumidifier tubing 22 is received in the receiving room 211, and the dehumidifying tubing 22 is connected between the inlet 212 and the outlet 213 of the inside of the outer housing 21. The humidity absorbent 23 is received in the receiving room 211, and the humidity absorbent 23 is located between the dehumidifying tubing 22 and the drain valve structure 24.

[0022] It is known that the dehumidifying tubing 22 provides water vapor permeability. Specifically, the tubing wall of the dehumidifying tubing 22 is made of a special material similar to a semi-permeable membrane, so that water contents are allowed to be released from the interior of the dehumidifying tubing 22 to the exterior of the dehumidifying tubing 22 through the tubing wall; conversely, substances out of the dehumidifying tubing

22 cannot enter into the interior of the dehumidifying tubing 22 through the tubing wall again. It is understood that, though the dehumidifying tubing is applied here, embodiments are not limited thereto; equivalent tubes with the same function for selectively releasing the water contents in the tubing are also applicable. When the gas sample with water contents enters into the dehumidifier 20 from the inlet 212, the water contents in the gas sample can be reduced by delivering the gas sample through the dehumidifying tubing 20. Hence, when the gas sample enters into the detector 10 from the outlet 213, the detector 10 can perform a better detection for the certain organic compound in the gas sample so as to measure the concentration of the certain organic compound in the gas sample more accurately. In general, pumps may be utilized to deliver the gas sample from the inlet 212 to the outlet 213 through the dehumidifying tubing 22, and the flowing speed of the gas sample, the tubing diameter, the tubing length, the operating temperature, and other parameters can be adjusted, so that the gas sample delivered to the outlet can be adjusted to a certain relative humidity range.

[0023] Please refer to Fig. 4. Fig. 4 illustrates a schematic operational view of the photoionization detecting device with dehumidifying function of the first embodiment. As shown in Figs. 3 and 4, when the water contents are released from the gas sample in the dehumidifying tubing 22 and stay in the receiving room 211 of the outer housing 21, the humidity absorbent 23 absorbs the water in the receiving room 211. As shown, in operation of the PID device 1, the detector 10 is at one side of the dehumidifier 20, and the humidity absorbent 23 is located below the dehumidifying tubing 22. Hence, due to the gravity force, the water contents released from the dehumidifying tubing 22 fall on the humidity absorbent 23 along a gravity direction W. Moreover, when the dehumidifier 22 is used for a period, the humidity absorbent 23 may already absorb a plenty of water and fails to absorb more water; namely, the water in the humidity absorbent 23 is saturated.

Therefore, the drain valve structure 24 at the lowest position of the outer housing 21 allow the water contained in the receiving room 211 to be drained out of the dehumidifier 20 along the gravity direction W, thereby improving the dehumidifying efficiency and the lifetime of the dehumidifier 20.

[0024] In one or some embodiments, the dehumidifier 20 further comprises a cartridge 25. The cartridge 25 is received in the receiving space 211, and the cartridge 25 receives the humidity absorbent 23. Therefore, the humidity absorbent 23 can be positioned by the cartridge 25. Furthermore, in one or some embodiments, the cartridge 25 is a replaceable cassette cartridge. Therefore, when the humidity absorbent 23 in the dehumidifier 20 is to be replaced, the user does not need to replace the entire dehumidifier 20; instead, the user can just replace the cartridge 25 and the humidity absorbent 23 received in the cartridge 25. Hence, the repair and maintenance of the dehumidifier 20 can be achieved conveniently and the costs for the repair and maintenance of the dehumidifier 20 can be reduced.

[0025] In one or some embodiments, the dehumidifier 20 further comprises a cartridge holder 26. The cartridge holder 26 is received in the receiving room 211 of the outer housing 21, and the cartridge holder 26 fixes and supports the cartridge 25. Moreover, where the receiving room 211 contains a certain volume of water, the cartridge holder 26 allows the cartridge 25 to be isolated from the water, thereby preventing the water from entering into the humidity absorbent 23 to influence the humidity absorbing ability of the humidity absorbent 23. Therefore, the dehumidifying efficiency and the lifetime of the dehumidifier 20 can be improved.

[0026] In one or some embodiments, the humidity absorbent 23 may be magnesium chloride, but embodiments are not limited thereto; the humidity absorbent 23 may be lithium chloride. In some embodiments, the humidity absorbent 23 may be sodium

silicate. Furthermore, in one or some embodiments, the cartridge 25 further comprises a plurality of ventilation holes 251, or the cartridge 25 is of porous property. The diameter of each of the ventilation holes 251 is less than the size of the humidity absorbent 23, since the humidity absorbent 23 can be available in other forms, such as granules or flakes, other than in powder form. Accordingly, when the humidity absorbent 23 is received in the cartridge 25, water ~~moist~~ moisture can enter into the cartridge 25 through the ventilation holes 251 so as to be absorbed by the humidity absorbent 23. Moreover, because the diameter of the ventilation hole 251 is less than the size of the humidity absorbent 23, the humidity absorbent 23 does not get out of the cartridge 25 from the ventilation holes 251. In this embodiment, the humidity absorbent 23 is a bulk with pores in different pore sizes and the bulk is received in the cartridge 25, but embodiments are not limited thereto; the humidity absorbent 23 may be separated particles or powders.

[0027] Please refer to Figs. 1 to 4. In one or some embodiments, the outer housing 21 further comprises an upper case 21a, a lower case 21b, and a detachable structure. The detachable structure is adapted to assemble the upper case 21a and the lower case 21b with each other in a detachable manner. In this embodiment, the inlet 212 and the outlet 213 are located on the upper case 21a, the drain valve structure 241 is located on the lower case 21b, and the receiving room 211 is located between the upper case 21a and the lower case 21b. In other words, the upper case 21a and the lower case 21b define the receiving room 211. For example, the detachable structure may be an upper screw thread structure 21c (as indicated by the threaded portions on the upper case 21a) and a lower screw thread structure 21d (as indicated by the threaded portions on the lower case 21b), so that the upper case 21a and the lower case 21b may be threaded with each other to increase the tightness of the seal. In some embodiments, the detachable structure may be an elastic engagement structure or a male-female buckling structure. For example, where the

detachable structure is an elastic engagement structure, the upper case 21a may have an elastic engaging portion, the lower case 21b may have a buckling portion corresponding to the elastic engaging portion, and the elastic engaging portion can be elastically engaged with the buckling portion, so that the upper case 21a and the lower case 21b can be assembled with each other detachably. Conversely, where the detachable structure is a male-female buckling structure, the upper case 21a may have an ear portion, the lower case 21b may have a recessed groove corresponding to the ear portion, and the ear portion can be mated with the recessed groove, so that the upper case 21a and the lower case 21b can be assembled with each other detachably. In one or some embodiments, the outer housing 21 may further comprise a seal ring 21c. The seal ring 21c is sandwiched between the upper case 21a and the lower case 21b, so that the tightness of the seal of the outer housing 21 can be further improved. It is understood that, in this embodiment, the upper case 21a and the lower case 21b are assembled with each other through the detachable structure, but embodiments are not limited thereto. In some embodiments, the upper case 21a and the lower case 21b may be combined with each other through an undetachable structure; for example, the upper case 21a and the lower case 21b may be combined with each other by melting, adhering, fixedly mating, or other ways.

[0028] In one or some embodiments, the drain valve structure 24 comprises a drain hole 241 and a drain screw 242, and the drain screw 242 is adapted to open or close the drain hole 241 selectively. Specifically, in this embodiment, the drain screw 242 has an outer threaded portion 2421 at a front end thereof, and the outer threaded portion 2421 can be threaded with an inner threaded portion of a fixing nut 2411 in the drain hole 241. Therefore, the drain screw 242 can selectively open or close the drain hole 241. In one or some embodiments, the drain valve structure 24 further comprises a seal gasket 244, held flat and firmly in place with a metal washer 243, when in locking position. When the

drain screw 242 selectively closes the drain hole 241, the seal gasket 244 can be provided for preventing the leakage of the drain hole 241. Accordingly, when a user requires draining out the water in the receiving room 2111 by using the drain valve structure 24, the user may loosen the drain screw 242.

[0029] As shown in Figs. 1 and 4, in one or some embodiments, the detector 10 further comprises a filter 40 and a scrubber 50. In this embodiment, the filter 40 and the scrubber 50 are respectively configured at two sides of the dehumidifier 20. Specifically, in this embodiment, the filter 40 is connected to the upper case 21a of the outer housing 21 to be in communication with the inlet 212,. Hence, the PID device 1 can perform self-cleaning and self-zeroing functions. On the other hand, the scrubber 50 is connected to the filter adaptor unit 30 to be in communication with the adaptor inlet 301, and the engineered charcoal granules are stored in the scrubber 50, so that the gas sample can be scrubbed before the gas sample enters the ionization chamber of the PID device 1. Moreover, the filter 40 and the scrubber 50 can be respectively connected to the outer housing 21 and the filter adaptor unit 30 through connector fittings.

[0030] Fig. 5 illustrates a partial sectional view of a photoionization detecting device with dehumidifying function according to a second embodiment of the instant disclosure. As shown in Fig. 5, in this embodiment, the cartridge holder 26’ further comprises a plurality of elastic arms 261’, and the elastic arms 261’ clamp the cartridge 25’, respectively. Moreover, in this embodiment, the outer wall of the cartridge 25’ has a plurality of engaging portions 251’, and the engaging portions 251’ correspond to the elastic arms 261’, so that the engaging portions 251’ are clamped by the elastic arms 261’. It is understood that, in this embodiment, the engaging portions 251’ are recessed portions for buckling with the protruding portions of the elastic arms 261’, but embodiments are not limited thereto; the engaging portions 251’ of the cartridge 25’ may be protruding

portions for buckling with the elastic arms 261' of the cartridge holder 26'.

[0031] It is understood that, in the forgoing embodiments, the shape of the outer housing 21 is a cylinder, but embodiments are not limited thereto; the outer housing 21 may be of other geometrical shapes or irregular shapes.

[0032] Please refer to the Table 1 below and Fig. 6. Table 1 indicates the experiment data showing the relative humidity of a gas sample processed with the dehumidifier 20 and without the dehumidifier 20, while Fig. 6 illustrates an experimental graph showing the relative humidity of a gas sample processed with the dehumidifier 20 and without the dehumidifier 20. In the experiments, the flowing speed of the gas sample in the dehumidifying tubing 22 is less than 0.5 liter/minute, while the overall measuring time is 12 hours. From the experiment results, as compared with the relative humidity measured from the gas sample without the application of the dehumidifier 20, the relative humidity measured from the gas sample with the application of the dehumidifier 20 is apparently reduced. Accordingly, the PID device 1 is more suitable for measurements of compounds with low concentration or for measurements of volatile organic compounds from the gas samples.

[0033] [Table 1]

Time (hour)	Relative humidity (RH) measured without the dehumidifier (RH %)	Relative humidity (RH) measured with the dehumidifier (RH %)
0.0	39.2	12.3
1.0	37.8	11.1
2.0	34.9	9.4
3.0	36.6	9.7
4.0	33.9	9.3
5.0	39.4	9.4
6.0	42.9	11.3

7.0	43.5	11.7
8.0	43.9	12.0
9.0	43.6	12.3
10.0	41.2	13.9
11.0	42.2	12.8
12.0	42.1	13.0

[0034] As above, according to one or some embodiments of the instant disclosure, the dehumidifying tubing of the dehumidifier can be provided for releasing an amount of the water in the gas sample into the receiving room, and the gas sample with reduced relative humidity is more suitable for the measurement of compounds in low concentration or for the measurement of volatile organic compounds from the gas samples. Moreover, in one or some embodiments, the dehumidifier may further comprise a cartridge, and the cartridge may be a replaceable cartridge. Therefore, when the humidity absorbent in the dehumidifier is to be replaced, the user does not need to replace the entire dehumidifier; instead, the user can just replace the cartridge and the humidity absorbent received in the cartridge. Hence, the repair and maintenance of the dehumidifier can be achieved conveniently and the costs for the repair and maintenance of the dehumidifier can be reduced.

CLAIMS

What is claimed is:

1. A photoionization detecting device with dehumidifying function, comprising:
   - a photoionization detector having a gas inlet; and
   - a dehumidifier comprising an outer housing, a dehumidifying tubing, and a humidity absorbent;
   - wherein an interior of the outer housing has a receiving room; the outer housing comprises an inlet, an outlet, and a drain valve structure, the outlet is connected to the gas inlet of the photoionization detector, and the drain valve structure is configured at a lowest position of the outer housing;
   - wherein the dehumidifying tubing is received in the receiving room, and the dehumidifying tubing is connected between the inlet and the outlet of the inside of the outer housing;
   - wherein the humidity absorbent is received in the receiving room, and the humidity absorbent is located between the dehumidifying tubing and the drain valve structure.
2. The photoionization detecting device with dehumidifying function according to claim 1, wherein the dehumidifier further comprises a cartridge, the cartridge is received in the receiving room of the outer housing, and the cartridge receives the humidity absorbent.
3. The photoionization detecting device with dehumidifying function according to claim 2, wherein the cartridge is a replaceable cassette cartridge.
4. The photoionization detecting device with dehumidifying function according to claim 2, wherein the dehumidifier further comprises a cartridge holder, the cartridge holder is received in the receiving room of the outer housing, and the cartridge holder fixes and

supports the cartridge.

5. The photoionization detecting device with dehumidifying function according to claim 2, wherein the cartridge comprises a plurality of ventilation holes or the cartridge is of porous property.

6. The photoionization detecting device with dehumidifying function according to claim 1, wherein the outer housing of the dehumidifier comprises an upper case, a lower case, and a detachable structure, the detachable structure is adapted to assemble the upper case and the lower case with each other being detachable.

7. The photoionization detecting device with dehumidifying function according to claim 6, wherein the detachable structure is a screw thread structure, an elastic engagement structure, or a male-female buckling structure.

8. The photoionization detecting device with dehumidifying function according to claim 6, wherein the outer housing further comprises a seal ring sandwiched between the upper case and the lower case.

9. The photoionization detecting device with dehumidifying function according to claim 1, wherein the drain valve structure comprises a drain hole, a seal gasket, a metal washer, a fixing nut, and a drain screw, the drain screw selectively opens or closes the drain hole.

10. The photoionization detecting device with dehumidifying function according to claim 1, further comprising a filter adaptor unit, the filter adaptor unit is connected between the outer housing and the photoionization detector.

11. The photoionization detecting device with dehumidifying function according to claim 1, wherein the humidity absorbent is selected from a group consisting of magnesium chloride, lithium chloride, and sodium silicate.

12. A dehumidifier, comprising:

– an outer housing, wherein an interior of the outer housing has a receiving room; the outer housing comprises an inlet, an outlet, and a drain valve structure, the drain valve structure is configured at a lowest position of the outer housing;

– a dehumidifying tubing received in the receiving room, wherein the dehumidifying tubing is connected between the inlet and the outlet of the inside of the outer housing; and

– a humidity absorbent received in the receiving room and located between the dehumidifying tubing and the drain valve structure.

13. The dehumidifier according to claim 12, further comprising a cartridge, the cartridge is received in the receiving room of the outer housing, and the cartridge receives the humidity absorbent; wherein the cartridge is a replaceable cassette cartridge.

14. The dehumidifier according to claim 13, further comprising a cartridge holder, wherein the cartridge holder is received in the receiving room of the outer housing, and the cartridge holder fixes and supports the cartridge.

15. The dehumidifier according to claim 13, wherein the cartridge comprises a plurality of ventilation holes or the cartridge is of porous property.

16. The dehumidifier according to claim 12, wherein the outer housing comprises an upper case, a lower case, and a detachable structure, the detachable structure is adapted to assemble the upper case and the lower case, with each other being detachable.

17. The dehumidifier according to claim 16, wherein the detachable structure is a screw thread structure, an elastic engagement structure, or a male-female buckling structure.

18. The dehumidifier according to claim 16, wherein the outer housing further comprises a seal ring sandwiched between the upper case and the lower case.

19. The dehumidifier according to claim 12, wherein the drain valve structure comprises a

drain hole, a seal gasket, a metal washer, a fixing nut, and a drain screw, the drain screw selectively opens or closes the drain hole.