

CIGARETTE ODOR REMOVAL APPARATUS

TECHNICAL FIELD

[0001] The present invention relates to cigarette odor removal apparatus to remove odors of cigarettes contained in circulating air.

BACKGROUND ART

[0002] Generally, in order to remove odors of cigarettes or a like contained in the air in a room and to clean the air, odor removal apparatus such as an air cleaning unit, odor removing unit, or the like is used.

[0003] As art odor removal apparatus of this kind, odor treatment apparatus (see Patent Reference 1) having an acid cleaning tower configured to remove odors having high concentration by using a biological desulfation agent and an alkali cleaning tower configured to remove odors by using sodium hydroxide or sodium hypochlorite, an air washer (see Patent Reference 2) to remove toxic gas components contained in air by using hydrochloric acid, sulfuric acid, and sodium hydroxide, and air cleaning apparatus (see Patent Reference 3) to remove various toxic gas components occurring from cigarettes by using activated carbon impregnated with a chemical for removal of acetaldehyde odors or activated carbon impregnated with a chemical for removal of alkali gas are known.

[0004] Also, air purifying/conditioning apparatus (see Patent Reference 4) having a humidification purifying section configured to perform humidification through

gas-liquid contact and to perform primary removal of soluble gas components and a cooling dehumidification section to cool air processed by the humidification purifying section and to perform dehumidification of part of water content humidified by the humidification purifying section and to perform secondary removal of soluble gas components, a system (see Patent Reference 5) to remove gas impurities contained in air by putting air into contact with a water film formed in a plurality of stages in a direction approximately orthogonal to the direction of air flow, contaminant removal apparatus (see Patent Reference 6) to suppress the growth of bacteria by lowering air temperatures in a spray chamber in which air is put into contact with sprayed water, and air purifying apparatus (see Patent Reference 7) to supply cleaned air while preventing the growth of bacteria or fungi in a water storage tank by placing a ultraviolet lamp and photocatalyst layer in a cleaning chamber where air is put into contact with sprayed water are known.

[0005] Moreover, exhaust gas treatment apparatus (see Patent Reference 8) which, after neutralizing and oxidizing offensive odor substances in exhaust gas in a scrubber for removal, allows residual offensive substances to be adsorbed by activated carbon for exhaustion into air and an air cleaning unit (see Patent Reference 9) to suck smoke of cigarettes together with air to allow cigarette tar to be adhered to a duct collection filter and to remove odors of cigarettes by applying ultraviolet rays to the duct collection filter to remove odors of cigarettes are known.

Patent Reference 1: Japanese Patent Application
Laid-open No. 2000 - 167344

Patent Reference 2: Japanese Patent Application
Laid-open No. 2005-257220

Patent Reference 3: Japanese Patent Application
Laid-open No. 2005 - 329195

Patent Reference 4: Japanese Patent Application
Laid-open No. 2000 - 27941

Patent Reference 5: Japanese Patent Application
Laid-open No. 2004-216296

Patent Reference 6: Japanese Patent Application
Laid-open No. 2005 - 211742

Patent Reference 7: Japanese Patent Application
Laid-open No. 2002 - 95724

Patent Reference 8: Japanese Patent Application
Laid-open No. 2004-261781

Patent Reference 9: Japanese Patent Application
Laid-open No. Hei 11-63593

However, the technologies stated in the Patent Reference 1 or 2 present problems in that, since deleterious substances such as hydrochloric acid or sulfuric acid are used as the chemical liquid, the above apparatus cannot be applied to indoor circulating type apparatus and that, since an alkali chemical such as sodium carbonate is used, these chemicals bind to a calcium ion or magnesium ion in water to produce CaCO_3 and/or MgCO_3 , which causes the deposition of scale in a pipe.

[0006] Also, the art stated in the Patent Reference 3 has

problems that performance of activated carbon impregnated with the chemical for removal of acetaldehyde gas or with the chemical for removal of alkaline gas is degraded due to adsorption of toxic gas and there is provided no filter to remove dust particles and, therefore, removal capability decreases rapidly.

Moreover, the art stated in the Patent Reference 4 also presents problems that slime grows in circulating water, causing the clogging of a pipe and that offensive odors caused by the slime flow into a room. Another problem is that, in order to prevent these problems, the disposition of an activated carbon filter or chemical filter on the downstream side of the purifying portion or water film is required, which causes an increase in costs.

[0007] Also, the art stated in the Patent Reference 6 presents problems in that, though the growth speed of bacteria can be suppressed by decreasing an air temperature in a sprayed chamber, the occurrence of bacterial cannot be suppressed and in that, depending on a kind of a microorganism, the suppression of growth speed of bacteria is impossible.

[0008] Also, the art stated in the Patent Reference 7 has problems in that, when a chemical is used as a photocatalyst layer, the chemical is oxidized and decomposed; for example, citric acid is oxidized to become aconitic acid or isocitric acid, which causes the odor removal function to become ineffective, or a chemical is changed into a different substance, for example, glycine is oxidized to produce ammonia which becomes

odor-producing source.

[0009] Moreover, the art stated in the Patent Reference 8 also has problems in that, though large mist particles are removed when exhaust gas passes through the scrubber, the relative humidity of the exhaust gas having passed through the activated carbon becomes almost 100%, which causes degradation in odor removal performance and, as a result, residual odor substances cannot be removed.

[0010] Furthermore, the art stated in the Patent Reference 9 also presents problems in that, though the art can remove dust particles and odors of cigarette tar, it is impossible to remove 400 kinds or more of gas-like cigarettes odors.

[0011] The present invention has been made in light of the problems described above and has an object to provide cigarette odor removal apparatus that can be applied to indoor circulating type apparatus and also can maintain high odor removal performance and does not allow scale to occur in a pipe.

DISCLOSURE OF THE INVENTION

[0012] The present invention is characterized in that the apparatus is cigarette odor removal apparatus for removing odors of cigarettes contained in circulating air, having a chemical odor removal unit to clean the circulating air by a chemical liquid containing a chemical composed of a food additive, wherein the food additive contains at least one chemical out of a chemical for

removal of alkaline gas, a chemical for removal of acid gas, and a chemical for removal of aldehyde gas.

[0013] It is preferable that the chemical for removal of the alkali gas contains citric acid, the chemical for removal of the acid gas contains sodium carbonate, and the chemical for removal of aldehyde gas contains glycine.

[0014] It is preferable that the chemical odor removal unit is made up of a first liquid storage tank to store any one of the chemical for removal of the alkaline gas and the chemical for removal of the acid gas and a second liquid storage tank to store the other chemical, first chemical media to which the one chemical is supplied, second chemical media to which the other chemical is supplied, a first circulating line provided so that the one of the chemicals is able to be circulated between the first liquid storage tank and the first chemical media, and a second circulating line provided so that the other chemical is able to be circulated between the second liquid storage tank and the second chemical media, wherein a switching unit is connected to the first circulating line and the second circulating line and by switching the switching unit, circulation of the one chemical is made possible between the first liquid storage tank and the second chemical media and circulation of the other chemicals is made possible between the second liquid storage tank and the first medical media.

[0015] It is preferable that the chemical to be used in the chemical odor removal unit can be ordinarily and additionally supplemented.

[0016] It is preferable that a sterilizing unit is provided in a vicinity of each of the first chemical media and the second chemical media and in each of the first liquid storage tank and the second liquid storage tank.

[0017] It is preferable that a water cleaning unit to put the circulating air into a state of saturated vapor is provided on the upstream side of the chemical odor removal unit and activated carbon is provided on the downstream of the chemical odor removal unit, and a heating unit to heat the circulating air so that the relative humidity of the circulating air becomes less than a predetermined humidity is provided between the chemical odor removal unit and the activated carbon.

[0018] Thus, according to the present invention, since, in the chemical odor removal unit, circulating air is cleaned by using the chemical, which is made up of a food additive, being safe for a human body, the cigarette odor removal apparatus can be applied to indoor circulating type apparatus. By providing the chemical odor removal unit, odors of cigarettes can be removed with reliability, thereby enabling high odor removal performance to be maintained. By providing the chemical odor removal unit with the switching unit, it is possible to prevent the occurrence of scale in the chemical media and/or pipe.

BRIEF DESCRIPTION OF DRAWINGS

[0019]

Figure 1 is a schematic diagram showing cigarette odor removal apparatus of an embodiment of the present

invention.

Figure 2 is a schematic diagram showing a chemical odor removal unit of the cigarette odor removal apparatus of the embodiment of the present invention.

Figure 3 is a comparison diagram showing results from measurement of relations of acetaldehyde removal rate and elapsed time between the cigarette odor removal apparatus of the present invention and the prior cigarette odor removal apparatus .

Figure 4 is a schematic diagram showing the prior cigarette odor removal apparatus.

BEST MODE CARRYING OUT THE INVENTION

[0020] Hereinafter, an embodiment of the present invention is described by referring to drawings.

[0021] Figure 1 is a diagram showing cigarette odor removal apparatus of the embodiment of the present invention, inside the enclosure of which a high-performance dust removal filter 11 to remove dust particles in circulating air, a water cleaning unit 12 to remove water-soluble gas in the circulating air, a chemical odor removal unit 13 to clean the circulating air by a chemical in a chemical liquid, a heating unit (heater) 14 to heat the circulating air, activated carbon 15 to remove volatile organic compounds in the circulating air, and a blower 16 to transfer the circulating air are provided in order from an upstream side along a direction (along an arrow direction shown in Fig. 1) of circulating air flow.

[0022] The water cleaning unit 12 includes water cleaning media 17 made up of a porous material, a honeycomb structural body, or the like, a water spraying pipe 18 disposed on an upper portion of the water cleaning media 17, and a drainage pipe 19 disposed on a lower portion of the water cleaning media 17, wherein the circulating air is maintained as a state of saturated vapor by its passage through the water cleaning media 17 on which water is sprayed.

[0023] The chemical odor removal unit 13 includes chemical media 20 made up of the porous material, honeycomb structural body, or the like, a chemical spraying pipe 21 disposed in an upper portion of the chemical media 20, a liquid storage tank 22 disposed in a lower portion of the chemical media 20, a circulating line 24 to circulate a chemical liquid between the liquid storage tank 22 and the chemical media 20 by connecting the chemical spraying pipe 21 to the liquid storage tank 22 to send the chemical liquid to transfer, with pressure, the chemical liquid by a circulating pump 23, a sterilizing unit 25 disposed in the vicinity of the chemical media 20, and a sterilizing unit 26 disposed inside the liquid storage tank 22, wherein a chemical liquid containing a specified chemical is to be ordinarily and additionally supplemented in the liquid storage tank 22.

[0024] All the chemicals contained in this chemical liquid are chemicals being able to be used in food additives and being safe for a human body, which contains three kinds of chemicals including an alkaline gas removal

chemical, an acid gas removal chemical, and an aldehyde gas removal chemical. Moreover, the chemical odor removal unit 13 preferably contains these three kinds of chemicals including the alkaline gas removal chemical, acid gas removal chemical, and aldehyde gas removal chemical, however, so long as the chemical odor removal unit 13 contains at least one chemical out of these three chemicals, it does not necessarily contain all these three chemicals.

[0025] Citric acid is preferably used as the alkaline gas removal chemical, however, DL-malic acid, succinic acid, L-tartaric acid, DL-tartaric acid, phosphoric acid, or the like may be used. Also, sodium carbonate is preferably used as the acid gas removal chemical, however, sodium hydrogen carbonate, potassium carbonate, trisodium phosphate, or the like may be used. Moreover, glycine is preferably used as the aldehyde removal chemical, however, alanine, arginine, asparagines, aspartic acid, glutamine, glutamic acid, histidine, isoleucine, leucine, lysine, methionine, serine, threonine, valine, cysteine, or the like may be used.

[0026] In the chemical removal unit 13, 3 sets of the liquid storage tank 22, chemical media 20, and circulating line 24 are provided for each of the alkaline gas removal chemical, acid gas removal chemical, and aldehyde gas removal chemical. The chemical removal unit 13 for the alkaline gas removal chemical and acid gas removal chemical, as shown in Fig. 2, has a first liquid storage tank 22a to store any one of the alkaline gas removal

chemical and acid gas removal chemical (citric acid as the alkaline gas removal chemical in Fig. 2), a second liquid storage tank 22b to store the other chemical (sodium carbonate as the acid gas removal chemical in Fig. 2), a first chemical media 20a to which the one chemical is supplied, a second chemical media 20b to which the other chemical is supplied, a first circulating line 24a to circulate the one chemical between the first liquid storage tank 22a and the first chemical media 20a, and a second circulating line 24b to circulate the other chemical between the second liquid storage tank 22b and second chemical media 20b.

[0027] The first circulating line 24a is equipped with a first circulating pump 23a and the second circulating line 24b has a second circulating pump 23b. A switching unit 27 is provided between the first circulating line 24a and second circulating line 24b. The switching unit 27 has first and second 3-way valves 30a and 30b each connected in a midway of each of a first outgoing pipe 28a to the first chemical media 20a and a second outgoing pipe 28b to the second chemical media 20b and second 3-way valves 31a and 31b each connected in a midway of each of a first return pipe 29a from the first chemical media 20a and a second return pipe 29b from the second chemical media 20b, a first switching line 32a to connect the first 3-way valve 30a for the first outgoing pipe 28a and the second 3-way valve for the second return pipe 29b from the second chemical media 20b to the first liquid tank 22a, and a second switching line 32b to connect the first 3-way valve

30b for the second outgoing pipe 28b and the first 3-way valve for the first return pipe 29a from the first chemical media 20a to the second liquid tank 22b. By switching the switching unit 27, the circulation of the one chemical between the first liquid tank 22a and the second chemical media 20b is made possible and the circulation of the other chemical between the second liquid tank 22b and the first chemical media 20a is made possible.

[0028] Next, actions of the cigarette odor removal apparatus 10 having the above configurations according to the embodiment of the present invention are explained.

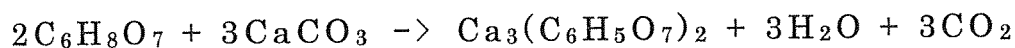
[0029] First, the circulating air returned back to the cigarette odor removal apparatus 10 from a room, after dust particles are removed by the high-performance dust removal filter 11, passes through the water cleaning media 17 in the water cleaning unit 12. Water is being sprayed from the water spraying pipe 18 and the circulating air having passed through the water cleaning media 17, after water-soluble gas has been removed from the circulating air, is put into a state of saturated vapor and is transferred to the chemical odor removal unit 13.

[0030] In the chemical odor removal unit 13, a chemical liquid, which is stored in the liquid storage tank 22, containing each of the chemicals including stored alkaline gas removal chemical (citric acid), acid gas removal chemical (sodium carbonate), and aldehyde gas removal chemical (glycine) is transferred, with pressure, through the circulating pump 23 to a chemical spraying pipe 21 and the circulating air having passed through the chemical

media is cleaned by three chemicals including the alkaline gas removal chemical (citric acid), acid gas removal chemical (sodium carbonate), and aldehyde gas removal chemical (glycine) and transferred to a heating unit 14.

[0031] In the operations, the switching unit 27 is manipulated periodically (for example, every one week) so that the state in which the alkaline gas removal chemical (citric acid) circulates through the first circulating line 24a and the acid gas removal chemical (sodium carbonate) circulates through the second circulating line 24b is switched to the state the alkaline gas removal chemical circulates through the first switching line 32a and the acid gas removal chemical circulates through the second switching line 32b. This causes following chemical reactions to occur among CaCO_3 , MgCO_3 , and the like accumulated in the first and second chemical media 20a and 20b and/or in the pipes.

Citric acid + calcium carbonate $\rightarrow$ calcium citrate + water
+ carbon dioxide
that is,



This chemical reaction can prevent the occurrence of scale in the first and second chemical media 20a and 20b and/or in the pipes.

[0032] The sterilizing unit 25 is disposed in the vicinity of the chemical media 20 and also the sterilizing unit 26 is

disposed inside the liquid storage tank 22, thereby suppressing and decreasing the occurrence of slime on the surface of the chemical media 20 and/or inside the liquid storage tank 22. Therefore, troubles of pipe occlusion caused by slime and/or odor occurrence can be prevented and periodic maintenance is not required, thus enabling the reduction of maintenance costs. Furthermore, By using not the photocatalyst but the sterilizing unit when the occurrence of slime is to be suppressed, the chemical contained in chemical liquid is neither oxidized nor decomposed, thus enabling high performance of odor removal of the chemical odor removal unit 13 to be maintained.

[0033] Next, in the heating unit 14, the circulating air having had its relative humidity of almost 100% in the chemical odor removal unit 13 is heated so that its relative humidity becomes less than a predetermined relative humidity (for example, 70%) and the heated circulating air is then transferred to the activated carbon 15 so that volatile organic compounds contained in the circulating air are removed. At this point of time, since the relative humidity of the circulating air passing through the activated carbon 15 becomes less than the predetermined relative humidity, the degradation in odor substance removal performance of the activated carbon 15 can be prevented.

[0034] Then, the circulating air having passed through the activated carbon 15 is transferred by the blower 16 to the room and is, thereafter, circulated between the room

and the cigarette odor removal apparatus 10.

[0035] Table 1 shows results from measurements of removal performance of the cigarette odor removal apparatus 10 obtained when 2 pieces of cigarettes were burnt and circulating air of 1,500 m³/h was allowed to pass through the cigarette odor removal apparatus 10 one time. According to Table 1, the cigarette odor removal apparatus 10 can remove 99% of dust particles, 77% of TVOC (total volatile organic compounds), 100% of nicotine, 81% of acetaldehyde, and 76% of ammonia, thus it is understood that the cigarette odor removal apparatus 10 can provide high removal performance. Moreover, N, D in the outlet column in Table 1 represents a result that is a level of being less than the limit of detection.

[0036] [Table 1]

Air cleaning apparatus	Inlet (μ g/m ³)	Outlet (μ g/m ³)	Removal rate(%)
Dust particles	482	7	99
TVOC (total volatile organic compounds)	311	72	77
Nicotine	30	N.D	100
Acetaldehyde	43	8	81
Ammonia	66	16	76

Figure 3 is a diagram showing results from comparison measurement between the removal rate of acetaldehyde and elapsed time in the case of the cigarette odor removal apparatus 10 of the embodiment of the present invention and in the case of the prior cigarette odor removal apparatus. At the time of the above comparison measurement, the number of cigarettes burnt

simultaneously was 6, processed amounts of wind was 250 m³/h, and inlet acetaldehyde concentration was 1,200 μg/m³. Moreover, Fig. 4 is a schematic diagram showing configurations of the prior cigarette odor removal apparatus 1 (that is, the air cleaner disclosed in Patent Reference 3 described above) which was used at the time of measurement performed in Fig. 3) and, in the case of the prior cigarette odor removal apparatus 1, in order from an upstream side along the direction of circulating air flow (arrow direction in Fig. 4), the activated carbon 2 impregnated with chemicals for acetaldehyde odor removal, activated carbon 3 impregnated with chemicals for alkali gas removal, and blower 4 are provided and the SV value [space velocity (1/h) = processed amounts of wind (m³/h)/volume of activated carbon (m³)] of the activated carbon 2 impregnated with the chemical for acetaldehyde odor removal was 46,000/h.

[0037] As is apparent from the measurement results shown in Fig. 4, in the case of the prior cigarette odor removal apparatus 1, the removal rate of acetaldehyde lowers with elapsed time, however, in the case of the cigarette odor removal apparatus 10 of the present invention, the chemical liquid containing a specified chemical is ordinarily and additionally supplemented in the liquid storage tank 22 in the chemical odor removal unit 13 and, therefore, no lowering of the removal rate of acetaldehyde occurs and high removal rate can be always maintained.

[0038] Table 2 shows comparison results from

measurement of the number of microorganisms in the liquid storage tank between the cigarette odor removal apparatus 10 of the embodiment of the present invention which has the sterilizing unit 26 made up of one piece of an ultraviolet lamp showing power consumption of 13.5 W and having a wavelength of 100 nm to 280 nm in the liquid storage tank 22 of 22 liters and the prior cigarette odor removal apparatus which has no sterilizing unit 26. Amounts of wind processed at the time of the measurement was 1,500 m³/h and the measurement results are values obtained after the lapse of one day following the placement of the sterilizing unit 26. Table 2 shows that the number of microorganisms in the liquid storage tank 22 is decreased greatly by mounting the sterilizing unit 26 in the liquid storage tank 22 and the occurrence of slime or the like are suppressed or reduced.

[0039] [Table 2]

	Prior art	Present invention
Ratio of numbers of microorganisms in liquid storage tank	10	1

Table 3 shows results from comparison measurement of the removal ratio of TVOC (total volatile organic compounds) between the cigarette odor removal apparatus 10 having the heating unit 14 (heater) of the embodiment of the present invention and the prior cigarette odor removal apparatus having no heater. At the time of the above comparison measurement, the number of cigarettes burnt simultaneously was 6 and amounts of wind processed

at the time of the measurement was 486 m³/h. As is apparent from the Table 3, in the case of the prior cigarette odor removal apparatus, the relative humidity of the circulating air passing through the activated carbon is as high as 97%, the odor removal performance lowered to 41%, however, in the case of the cigarette odor removal apparatus 10 of the present invention, the relative humidity of the circulating air passing through the activated carbon 15 has already lowered to 70% and, therefore, the degradation in odor removal performance can be prevented.

[0040] [Table 3]

	Upstream $\mu\text{g}/\text{m}^3$	Downstream $\mu\text{g}/\text{m}^3$	Removal rate	Relative humidity
Present invention (with heater)	1,020	395	61	70
Prior art (without heater)	934	548	41	97

Thus, according to the cigarette odor removal apparatus 10 of the embodiment of the present invention, since the circulating air is cleaned by using the chemical, which is made of food additives, being safe for a human body in the chemical odor removal unit 13, the cigarette odor removal apparatus can be applied to indoor circulation type apparatus accordingly. Moreover, the chemical to be used in the chemical odor removal unit 13 is ordinarily and additionally supplemented and, therefore,

unlike the prior activated carbon impregnated with the chemical for removal of aldehyde odors and activated carbon impregnated with the chemical for removal of alkaline gas, the odor removal performance is not degraded, whereby, the high removal performance can be maintained for a long time. Furthermore, by providing the high-performance dust removal filter 11, the water cleaning unit 12, and the chemical odor removal unit 13 in order from the upstream side along the direction of circulating air flow, it is made possible to remove not only dust particles in the circulating air but also gas components.

WHAT IS CLAIMED IS:

1. Cigarette odor removal apparatus for removing odors of cigarettes contained in circulating air comprising:

a chemical odor removal unit to clean the circulating air by using chemical liquid containing a chemical made of a food additive;

wherein the chemical odor removal unit comprises a first liquid storage tank to store any one of a chemical for removal of alkaline gas and a chemical for removal of acid gas, and a second liquid storage tank to store the other chemical, a first chemical media to which the one chemicals is supplied, a second chemical media to which the other chemical is supplied, a first circulating line provided so that the one chemical is able to be circulated between the first liquid storage tank and first chemical media, and a second circulating line provided so that the other chemical is able to be circulated between the second liquid storage tank and second chemical media and wherein a switching unit is provided in the first circulating line and in the second circulating line and, by switching the switching unit, circulation of the one chemical is made possible between the first liquid storage tank and second liquid storage tank and circulation of the other chemical is made possible between the second liquid storage tank and first chemical media.

2. The cigarette odor removal apparatus according to Claim 1, wherein the chemical to be used in the chemical odor removal unit is ordinarily and additionally supplemented.

3. The cigarette odor removal apparatus according to Claim 1 or Claim 2, wherein a sterilizing unit is provided in a vicinity of each of the first chemical media and second chemical media and in each of the first liquid storage tank and second storage tank.