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Treatment of Sulfur-Containing Gases

This invention relates to a process for treatment of gases which is useful for removal of hydrogen sulfide and carbonyl sulfide in inert or reducing gases.

Sulfur compounds such as hydrogen sulfide and carbonyl sulfide are contained in carbon dioxide gas for beverages, coke furnace gas, blast furnace gas, converter gas, thermal cracking gas of petroleum fractions, natural gas, etc. Since these sulfur compounds even in trace amounts present characteristic smell and offer a catalyst poisoning effect, these often give rise to problems in various steps such as carbonation of the beverage mixtures and chemical reactions.

In order to remove these sulfur compounds, there have been proposed removal processes comprising washing with chemical solutions such as alkali solutions and alkanolamine solutions, removal processes by adsorption utilizing iron oxides, zinc oxide, activated carbon, etc. and the like. However, these processes exhibit inferior removal efficiency and encounter difficulties particularly in the removal of carbonyl sulfide.

The present inventors, in view of such circumstances, conducted extensive investigation, and as a result, found that incorporation into activated carbon of a copper compound, an alkali metal compound and/or an alkaline earth metal compound led to highly efficient removal of hydrogen sulfide and carbonyl sulfide in gases. This finding has culminated in the completion of this invention.

Thus, this invention is concerned with a process for treatment of a gas containing hydrogen sulfide and/or carbonyl sulfide (hereinafter referred to as "sulfur compounds") but not substantially containing oxygen, which comprises contacting the gas with activated carbon (hereinafter referred to as "activated carbon containing metal compounds") containing (1) a copper compound and (2) an alkali metal compound and/or an alkaline earth metal compound (alkali metal compound and/or alkaline earth metal compound are collectively or independently referred to hereinafter as "second metal compound") at a temperature of not higher than 150°C, whereby sulfur compounds are removed from the gas.

The activated carbon, which is useful in this invention, may be any of the activated carbon which is manufactured by known processes utilizing coal, coke, charcoal, coconut shells, resins, etc. as raw material and shows a specific surface area of 200 to 2000 m²/g. And the activated carbon is used in a suitable shape, which varies with the intended process for treatment of gases, such as spherical beads, cylindrical pellets, crushed pieces, powder and threadlike pieces.

Examples of the copper compounds used in the present invention include oxides, hydroxides, and salts with inorganic acids (such as carbonates, basic carbonates, nitrates, sulfates, phosphates and halides) or with organic acids (e.g. carboxylates such as formates, acetates, oxalates, etc.).

Examples of the alkali metal compounds include compounds of Li, Na, K, Rb and Cs such as hydroxides, their inorganic salts being exemplified by hydrogen carbonates, carbonates, nitrates, borates, silicates, sulfate, halide, etc., and their salts with organic acids being typified by formates, acetates, oxalates, citrates, tartrates, benzoates, phenolates, sulfonates, etc.

Examples of the alkaline earth metal compounds

include compounds of Be, Mg, Ca, Sr and Ba, such as oxides, hydroxides, salts with inorganic acids being exemplified by carbonates, nitrates, sulfates, phosphates, halides, etc., and salts with organic acids being typified by formates, acetates, oxalates, etc.

The activated carbon containing metal compounds used in the present invention may be one containing both of the alkali metal compound and the alkaline earth metal compound.

The contents of the copper compound and the second metal compound in the activated carbon containing metal compounds are 0.1 mg atom to 3.0 mg atom as copper per g of activated carbon, preferably 0.2 mg atom to 2.0 mg atom, and 0.1 mg atom to 5.0 mg atom as alkali metal or as alkaline earth metal per g of activated carbon, preferably 0.2 mg atom to 4.0 mg atom, respectively. In case that the activated carbon containing metal compounds is one containing both of the alkali metal compound and the alkaline earth metal compound, the amount of one of the second metal compounds is 0.1 mg atom to 5.0 mg atom as metal per g of activated carbon, preferably 0.2 mg atom to 4.0 mg atom, and the amount of the other second metal compound is 0.1 mg atom to 5.0 mg atom as metal per g of activated carbon, preferably 0.2 mg atom to 4.0 mg atom.

The activated carbon containing metal compounds, which is useful in this invention, may contain as ~~the~~ a third component a compound of at least one kind of metal (hereinafter referred to as "third metal compound") selected from the group consisting of aluminum, titanium, vanadium, chromium, manganese, iron, cobalt, nickel, zinc, cadmium and lead, and the presence of the third metal compound highly improves the removal efficiency for sulfur compounds.

Examples of the third metal compounds include compounds of Al, Ti, V, Cr, Mn, Fe, Co, Ni, Zn, Cd and Pb, such as oxides, hydroxides, salts with inorganic

acids being exemplified by carbonates, hydrogencarbonates, nitrates, borates, silicates, sulfates, phosphates, halides, etc., ammonium salts and salts with organic acids being typified by formates, acetates, oxalates, citrates, etc.

5 In cases in which the third metal compound is further incorporated into the activated carbon containing metal compounds, the content of the third metal compound in the activated carbon is 0.1 to 5.0 mg atom as metal per g of
10 activated carbon, preferably 0.2 to 4.0 mg atom.

The activated carbon containing metal compounds according to this invention is prepared for example by the following processes:

- A. In case of the preparation of the activated carbon
15 containing a copper compound and a second metal compound;
(1) A process which comprises adding a copper compound and a second metal compound to a raw material for activated carbon and effecting carbonization and activation by a conventional method,
20 (2) A process which comprises adding a copper compound to a raw material for activated carbon, effecting carbonization/activation by a conventional method, admixing the resultant activated carbon with a second metal compound, and drying or calcining the mixture, if necessary,
25 (3) A process which comprises adding a second metal compound to a raw material for activated carbon, effecting carbonization/activation by a conventional method, admixing the resultant activated carbon with a copper compound, and drying or calcining the mixture, if necessary,
30 (4) A process which comprises admixing activated carbon simultaneously with a copper compound and a second metal compound, and drying or calcining the mixture, if necessary,
(5) A process which comprises admixing activated carbon with a copper compound, drying or calcining the mixture,
35 and admixing with a second metal compound, followed by drying or calcining, if necessary, and

(6) A process which comprises admixing activated carbon with a second metal compound, drying or calcining the mixture, and further admixing with a copper compound, followed by drying or calcining, if necessary.

5 B. In case of the preparation of the activated carbon containing both of an alkali metal compound and an alkaline earth metal compound as the second metal compound;

(1) A process which comprises adding a copper compound, an alkaline earth metal compound and an alkali metal
10 compound to a raw material for activated carbon, and effecting carbonization/activation by a conventional method,

(2) A process which comprises adding a copper compound to raw material for activated carbon, effecting
15 carbonization/activation by a conventional method, admixing the resultant activated carbon with an alkaline earth metal compound and an alkali metal compound, separately, and drying or calcining the mixture, if necessary,

(3) A process which comprises adding an alkaline earth
20 metal compound to a raw material for activated carbon, effecting carbonization/activation by a conventional method, admixing the resultant activated carbon with a copper compound and an alkali metal compound, either simultaneously or separately, and drying or calcining the mixture, if
25 necessary,

(4) A process which comprises adding an alkali metal compound to a raw material for activated carbon, effecting carbonization/activation by a conventional method, admixing the resultant activated carbon with a copper compound
30 and an alkaline earth metal compound, either simultaneously or separately, and drying or calcining the mixture, if necessary,

(5) A process which comprises admixing activated carbon with a copper compound, an alkaline earth metal compound
35 and an alkali metal compound simultaneously, and drying or calcining the mixture, if necessary,

(6) A process which comprises admixing activated carbon with a copper compound, drying or calcining the mixture, admixing it further with an alkaline earth metal compound and an alkali metal compound, either simultaneously or
5 separately, and drying or calcining the mixture, if necessary,

(7) A process which comprises admixing activated carbon with an alkaline earth metal compound, drying or calcining the mixture, and admixing it further with a copper compound
10 and an alkali metal compound, either simultaneously or separately, followed by drying or calcining, if necessary, and

(8) A process which comprises admixing activated carbon with an alkali metal compound, drying or calcining the mixture,
15 and admixing it further with a copper compound and an alkaline earth metal compound, either simultaneously or separately, followed by drying or calcining, if necessary.

C. In case of the preparation of the activated carbon containing a copper compound, a second metal compound and a
20 third metal compound;

(1) A process which comprises adding a copper compound, a second metal compound and a third metal compound to a raw material for activated carbon, and effecting carbonization/activation by a conventional method,

25 (2) A process which comprises adding a copper compound to a raw material for activated carbon, effecting carbonization/activation by a conventional method, admixing the resultant activated carbon with a second metal compound and a third metal compound, separately, and
30 drying or calcining the mixture, if necessary,

(3) A process which comprises adding a second metal compound to a raw material for activated carbon, effecting carbonization/activation by a conventional method, admixing the resultant activated carbon with a copper
35 compound and a third metal compound, either simultaneously or separately, and drying or calcining the mixture, if

necessary,

(4) A process which comprises adding a third metal compound to a raw material for activated carbon, effecting carbonization/activation by a conventional method, admixing
5 the resultant activated carbon with a copper compound and a second metal compound, either simultaneously or separately, and drying or calcining the mixture, if necessary,

(5) A process which comprises admixing activated carbon with a copper compound, a second metal compound and a third
10 metal compound simultaneously, and drying or calcining the mixture, if necessary,

(6) A process which comprises admixing activated carbon with a copper compound, drying or calcining the mixture, admixing it further with a second metal compound and a
15 third metal compound, either simultaneously or separately, and drying or calcining the mixture, if necessary,

(7) A process which comprises admixing activated carbon with a second metal compound, drying or calcining the mixture, and admixing it further with a copper compound
20 and a third metal compound, either simultaneously or separately, followed by drying or calcining, if necessary, and

(8) A process which comprises admixing activated carbon with a third metal compound, drying or calcining the mixture, and
25 admixing it further with a copper compound and a second metal compound, either simultaneously or separately, followed by drying or calcining, if necessary.

In these preparation processes, the procedure of admixing activated carbon with metal compounds is considered
30 to involve impregnating or spraying activated carbon with a solution or suspension of metal compounds in water (inclusive of aqueous acid or alkali solution) or a variety of solvents.

In the above preparation processes, by "drying" is
35 understood a step which comprises evaporating the water or solvent in the admixed activated carbon at a temperature

of not higher than 130°C, and the term "calcining" denotes a step which comprises heating the admixed activated carbon thus dried under an atmosphere of a gas such as an inert gas, carbon dioxide gas, steam and waste combustion gas at a temperature of not lower than 130°C to thermally decompose part or all of the metal compounds.

In the above processes, when activated carbon is admixed with compounds other than oxides as the copper, second metal compounds (except alkali metal compounds) and third metal compounds, it is favorable to effect heat treatment such as drying or calcining after the admixing; in cases in which activated carbon is admixed with a copper compound, a second metal compound (except alkali metal compound) and a third metal compound but is not subjected to heat treatment, it is preferred to use oxides as the copper, second metal (except alkali metal) and third metal compounds; when activated carbon is admixed with alkali metal compounds other than hydroxides, carbonates and hydrogen carbonates of alkali metal as the second metal compound, it is advantageous to effect heat treatment such as drying or calcining after the admixing; and in cases in which activated carbon is admixed with alkali metal compounds without subsequent heat treatment, it is favorable to use hydroxides, carbonates or hydrogencarbonates as the alkali metal compound.

The gas not containing substantially oxygen which ~~is~~^{are} useful in this invention include those having an oxygen concentration of not more than 2 vol.%. These gases may be exemplified by carbon dioxide gas, coke furnace gas, blast furnace gas, converter gas, thermal cracking gas of petroleum fractions, natural gas, etc.

The process of this invention is conducted into practice by contacting the activated carbon containing metal compounds as obtained by the above procedure with a gas containing sulfur compounds. The solid-gas contacting

method is by use of the known means such as the fixed bed, moving bed and fluidized bed, whereby the contacting temperature is not higher than 150°C, preferably 0 to 150°C, and the gas pressure is preferably not higher than 50 kg/cm², more preferably 0.1 to 40 kg/cm², with the gas contacting time being preferably 1/10 to 100 seconds as measured at 25°C and 1 kg/cm², more preferably 1/5 to 80 seconds.

The examples are described below to illustrate this invention more specifically.

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Example 1

The activated carbon A of 16 to 24 mesh through having a B.E.T. specific surface area of 1040 m²/g was sprayed uniformly with a solution of the determined amount each of copper nitrate and nitrate of an alkali metal. 50 ml of the admixed product thus obtained was packed into a 4-cm ø column made of quartz glass. The column was heated at a heating rate of 2 °C/min. While allowing a nitrogen gas to flow therethrough at a linear flow rate of 10 cm/sec., and the packed product was calcined at 350°C for 30 minutes.

The contents of the copper and alkali-metal compounds in the catalyst thus obtained were 0.2 to 2.0 mg atom as copper and 0.2 to 2.0 mg atom as alkali metal per g of activated carbon, respectively.

As a control reference, the activated carbon was admixed with copper nitrate solely or with nitrate of an alkali metal solely by the same procedure as mentioned above, and was calcined in a nitrogen gas at 350°C for 30 minutes to prepare a catalyst.

15 ml each of the catalysts thus obtained was packed into a 1.6-cm ø glass column. A gas at 40°C containing 12.5 ppm of COS (N₂-97.5 vol.% and H₂O-2.5 vol.%) was allowed to pass through the column at a linear flow rate of 40 cm/sec. to conduct a break-through adsorption test on COS. The results are as shown in Table 1.

Example 2

A 12 ml portion each of the catalysts A through M shown in Table 1 was packed into a 1.6 cm ϕ glass column. A gas of 25°C containing 10.0 ppm of H_2S (N_2 -97.5 vol.% and H_2O -2.5 vol.%) was passed through the column at a linear flow rate of 40 cm/sec. to conduct a break-through adsorption test on H_2S . The results are as shown in Table 2.

Example 3

10 The determined amount each of Li_2CO_3 , Na_2SO_4 , K_2SO_4 , Rb_2SO_4 , ~~Ca~~ ^{Cs} $_2SO_4$, $HCOONa$, CH_3COOK and $(COONa)_2$ was incorporated into a coconut-shell raw material. After being mixed and crushed, the mixture was kneaded with various kinds of pitch, water, etc., and molded into
15 cylindrical pellets of 4 mm ϕ . The pellets were carbonized at 650°C and further steam-activated at 900°C. The resultant activated carbon showed a B.E.T. specific surface area of 1000 to 1100 m^2/g and a content of the alkali metal compound of 0.8 to 1.1 mg atom as metal per g
20 of activated carbon, as shown in Table 3.

Various kinds of the activated carbon ~~was~~^{are} crushed and sieved to a uniform grain size of 16 to 24 mesh through, and each was sprayed with a solution of the determined amount of copper sulfate in water. 50 ml
25 each of the admixed products thus obtained was packed into a 4 cm ϕ column made of quartz glass. The column was heated at a heating rate of 2 °C/min., while a nitrogen gas was allowed to pass through it at a linear flow rate of 10 cm/sec., and the packed product was calcined at 350°C
30 for 30 minutes. The contents of the copper compound in the resultant catalysts were 1.0 mg atom as metal per g of activated carbon.

15 ml each of the catalysts N through U thus obtained was packed into a 1.6-cm ϕ glass column, and a gas ~~of at~~
35 40°C containing 12.5 ppm of COS (N_2 -97.5 vol.% and H_2O -2.5 vol.%) was passed through the column at a linear flow

rate of 40 cm/sec. to conduct a break-through adsorption test on COS. The results are as shown in Table 3.

Example 4

5 The determined amount each of CuO , CuSO_4 , $(\text{CH}_3\text{COO})_2\text{Cu}$, $(\text{HCOO})_2\text{Cu}$ and CuCl_2 was incorporated into a coconut-shell raw material. After being mixed and crushed, the mixture was kneaded with various kinds of pitch, water, etc., and molded into cylindrical pellets of 4-mm ϕ . The pellets
10 were carbonized at 650°C and further steam-activated at 900°C . The resultant activated carbon showed a B.E.T. specific surface area of 1000 to 1100 m^2/g and a content of the copper compound of 0.8 to 1.1 mg atom as metal per g of activated carbon.

15 Various kinds of the activated carbon were crushed and sieved to a uniform grain size of 16 to 24 mesh through, and each was sprayed with a solution of the determined amount of an alkali metal nitrate in water. 50 ml each of the admixed products thus obtained was packed into a 4-cm ϕ
20 column made of quartz glass. The column was heated at a heating rate of $2^\circ\text{C}/\text{min.}$, while a nitrogen gas was allowed to pass through it at a linear flow rate of 10 cm/sec, and the packed material was burnt at 300°C for 30 minutes. The contents of the alkali metal compounds
25 in the resultant catalysts were 1.0 mg atom as metal per g of activated carbon.

 15 ml each of the catalysts V through Z thus obtained was packed into a 1.6 cm ϕ glass column, and a gas of 40°C containing 12.5 ppm of COS (N_2 -97.5 vol.% and H_2O -2.5
30 vol.%) was passed through the column at a linear flow rate of 40 cm/sec. to conduct a break-through adsorption test on COS. The results are as shown in Table 4.

Example 5

35 A 15 ml portion each of the catalysts F and I shown in Table 1 was packed into a 1.6 cm ϕ glass column, and a

gas containing 12.5 ppm of COS (CO-97.5 vol.% and H₂O-2.5 vol %) was passed through the column at temperatures of 25, 60, 80 and 120°C (in all cases, the linear flow rate of the gas was maintained at 40 cm/sec. as converted to 25°C).

5 The COS concentrations in the gases withdrawn at the inlet and outlet of the column were measured by means of FPD gas chromatography, and the COS removal ratios were determined. The results are as shown in Table 5.

Table 1

Catalyst	Amount of copper (mg-atom/g)	Kind and amount of alkali metal (mg-atom/g)	Percent removal of COS at the time points shown below (%)				
			15hrs. later	25 hrs. later	50 hrs. later	75 hrs. later	100 hrs. later
A(control)	0	0	0	0	0	0	0
B(")	2.00	0	98	68	8	0	0
C(")	0	K-2.0	100	50	0	0	0
D(present invention)	0.2	K-1.0	100	100	18	8	1
E(")	0.5	K-1.0	100	100	49	10	3
F(")	1.0	K-1.0	100	100	100	97	82
G(")	2.0	K-1.0	100	100	100	99	90
H(")	1.0	K-0.2	100	100	92	68	36
I(")	1.0	K-0.5	100	100	100	90	73
J(")	1.0	Li-0.5	100	100	85	63	54
K(")	1.0	Na-0.5	100	100	94	78	45
L(")	1.0	Rb-0.5	100	100	100	90	79
M(")	1.0	Cs-0.5	100	100	100	85	70

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Table 2

Catalyst	Amount of copper (mg-atom/g)	Kind and amount of alkali metal (mg-atom/g)	Percent removal of H ₂ S at the time points shown below (%)				
			50hrs. later	100hrs. later	150hrs. later	200hrs. later	250hrs. later
A(control)	0	0	0	0	0	0	0
B(")	2.0	0	100	77	38	9	0
C(")	0	K-2.0	100	58	5	0	0
D(present invention)	0.2	K-1.0	100	100	83	64	42
E(")	0.5	K-1.0	100	100	100	93	81
F(")	1.0	K-1.0	100	100	100	97	92
G(")	2.0	K-1.0	100	100	100	98	95
H(")	1.0	K-0.2	100	100	99	92	79
I(")	1.0	K-0.5	100	100	100	95	90
J(")	1.0	Li-0.5	100	100	90	83	69
K(")	1.0	Na-0.5	100	100	95	88	75
L(")	1.0	Rb-0.5	100	100	100	93	89
M(")	1.0	CS-0.5	100	100	100	89	80

Table 3

Catalyst	BET specific surface area (m ² /g)	Kind of alkali metal salt and amount of alkali metal (mg-atom/g)	Amount of copper (mg-atom/g)	Percent removal of COS at the time points shown below (%)			
				10hrs. later	25hrs. later	50hrs. later	100hrs later
N	1050	Li ₂ CO ₃ - 0.85	1.0	100	100	78	65
O	1100	Na ₂ CO ₃ - 0.98	1.0	100	100	80	68
P	1010	K ₂ SO ₄ - 0.94	1.0	100	100	95	79
Q	1090	Rb ₂ SO ₄ - 1.05	1.0	100	100	93	84
R	1050	Ca SO ₄ - 1.00	1.0	100	100	89	70
S	1100	HCOONa - 0.93	1.0	100	100	78	63
T	1080	CH ₃ COOK - 0.89	1.0	100	100	93	84
U	1020	(COONa) ₂ -1.03	1.0	100	100	75	60

Table 4

Catalyst	BET specific surface area (m ² /g)	Kind of copper compound and amount of copper (mg-atom/g)	Kind of alkali metal salt and amount of alkali metal (mg-atom/g)	Percent removal of COS at a time point shown below (%)			
				10hrs. later	25hrs. later	50hrs. later	100hrs. later
V	1050	CuO - 0.95	LiNO ₃ - 1.0	100	100	83	72
W	1010	CuSO ₄ - 1.10	NaNO ₃ - 1.0	100	100	90	81
X	1070	(CH ₃ COO) ₂ Cu-0.91	KNO ₃ - 1.0	100	100	98	83
Y	1100	(HCOO) ₂ Cu-1.00	RbNO ₃ - 1.0	100	100	90	75
Z	1050	CuCl ₂ - 0.88	CsNO ₃ - 1.0	100	100	85	71

Table 5

Contacting temperature (°C)	Catalyst	Percent removal of COS at the time point shown below (%)			
		10hrs. later	25hrs. later	50hrs. later	100hrs. later
25	F	100	100	95	88
	I	100	100	84	80
60	F	100	100	100	95
	I	100	100	100	89
80	F	100	100	100	98
	I	100	100	100	88
120	F	100	100	100	98
	I	100	100	100	75

Example 6

The activated carbon A of 16 to 24 mesh through having a B.E.T. surface area of $1040 \text{ m}^2/\text{g}$ was sprayed uniformly with a solution in water of the two components (i.e. copper nitrate and nitrate of an alkaline earth metal), or the three components (i.e. copper nitrate, an alkaline earth metal compound and a third metal compound or alkali metal compound (nitrate)), 50 ml of the resultant admixed product was packed into a 4 cm ϕ column made of quartz glass. The column was heated at a heating rate of 5 °C/min., while a nitrogen gas was allowed to pass through it at a linear flow rate of 10 cm/sec., and the packed product was calcined at 300°C for 30 minutes.

The contents of the copper compound, alkaline earth metal compound, alkali metal and third metal compound in the catalysts thus obtained were all 0.2 to 2.0 mg atom as metal per lg of activated carbon, as shown in Table 6.

As the control reference, the activated carbon was

admixed with copper nitrate, nitrate of an alkaline earth metal and a third metal compound alone, respectively, by the same procedure as mentioned above, and the admixed products were calcined in a nitrogen gas at 300°C for 5 30 minutes to prepare the catalysts.

15 ml each of the catalysts a through j (control references) and 1 to 47 thus obtained was packed into a 1.6 cm ϕ glass column, and a gas of 50°C containing 12.5 ppm of COS (N_2 -97.5 vol.%, H_2O -2.5 vol.%) was passed 10 through it at a linear flow rate of 40 cm/sec to conduct a break-through adsorption test on COS. The results are as shown in Table 6.

Example 7

15 A 12 ml portion each of the catalysts a through j (control references) and 1 through 47 of Example 6 was packed into a 1.6 cm ϕ glass column, and a gas of 30°C containing 10.0 ppm of H_2S (N_2 -97.5 vol.%, H_2O -2.5 vol.%) was passed through it at a linear flow rate of 40 cm/sec. 20 to conduct a break-through adsorption test on H_2S . The results are as shown in Table 7.

Example 8

The determined amount each of an alkaline earth 25 metal compound and alkali metal compound or a third metal compound were added to a coconut-shell raw material. After being mixed and crushed, the mixture was kneaded with various kinds of pitch, water, etc., and molded into cylindrical pellets of 4 mm ϕ . These pellets were 30 carbonized at 650°C and further steam-activated at 900°C. Various kinds of the resultant activated carbon showed a B.E.T. specific surface area of 950 to 1150 m^2/g , with their contents of the alkaline earth metal and third metal compounds being all within the range of 0.8 to 1.1 35 mg atom per g of activated carbon, as shown in Table 8.

Various kinds of such activated carbon were crushed

and sieved to a uniform grain size of 16 to 24 mesh through, and sprayed with a solution of the determined amount of copper compound in 2% aqueous acetic acid. 50 ml of each of the admixed products thus obtained was packed
5 into a 4 cm ϕ column made of quartz glass. The column was heated at a heating rate of 5 °C/min., while a nitrogen gas was allowed to pass through it at a linear flow rate of 10 cm/sec., and the packed product was calcined at 300°C for 30 minutes. The content of the copper compound
10 in the catalyst was 1.0 mg atom per g of activated carbon.

15 ml each of the catalysts 48 through 76 thus obtained was packed into a 1.6 cm ϕ glass column, and a gas of 50°C containing 12.5 ppm of COS (CO-97.5 vol.% and H₂O-2.5 vol.%) was passed through it at a linear flow rate
15 of 40 cm/sec. to conduct a break-through adsorption test on COS. The results are as shown in Table 8.

Example 9

A 15 ml portion of each of the catalysts 3 , 9 ,
20 13 , 20 , 30 and 37 of Example 6 was packed into a 1.6 cm ϕ glass column, and a gas containing 12.5 ppm of COS (N₂-97.5 vol.% and H₂O-2.5 vol.%) was passed through it at 25 , 60 , 80 and 120°C, respectively (in every case, a gas linear flow rate was maintained
25 at 40 cm/sec. as measured at 25°C).

The COS concentrations at the outlet and inlet of the column were measured by means of FPD gas chromatography to determine the COS removal rates at the determined points of time. The results are as shown in Table 9.

Table 6-1

Catalyst	Amount of copper (mg-atom/g)	Kind and amount of alkaline earth metal (mg-atom/g)	Kind and amount of alkali metal or third metal (mg-atom/g)	Percent removal of COS at the time point shown below (%)			
				25hrs. later	50hrs. later	75hrs. later	100hrs. later
control	a	0	0	0	0	0	0
	b	200	0	90	18	0	0
	c	0	Mg-2.0	35	0	0	0
	d	0	0	73	0	0	0
	e	0	Mg-1.0	78	0	0	0
	f	0	Mg-1.0	40	3	0	0
	g	0	Mg-1.0	60	11	0	0
	h	0	Mg-1.0	48	15	0	0
	i	0	Mg-1.0	100	48	18	4
	j	0	Mg-1.0	100	40	10	0
present invention	1	0.2	Mg-1.0	100	98	58	10
	2	0.5	Mg-1.0	100	100	88	23
	3	1.0	Mg-1.0	100	100	90	31
	4	2.0	Mg-1.0	100	100	95	45
	5	1.0	Mg-0.2	100	99	60	35

Table 6-2

Catalyst	Amount of copper (mg-atom/g)	Kind and amount of alkaline earth metal (mg-atom/g)	Kind and amount of alkali metal or third metal (mg-atom/g)	Percent removal of COS at the time point shown below (%)			
				25hrs. later	50hrs. later	75hrs. later	100hrs. later
present invention	6	Mg-0.5	0	100	100	75	55
	7	Be-1.0	0	100	100	70	30
	8	Ca-1.0	0	100	100	68	25
	9	Sr-1.0	0	100	100	88	32
	10	Ba-0.5	0	100	100	85	24
	11	Mg-0.5	K -1.0	100	100	100	89
	12	Mg-0.5	K -1.0	100	100	100	95
	13	Mg-0.5	K -1.0	100	100	100	98
	14	Mg-0.5	K -1.0	100	100	100	100
	15	Mg-0.5	Li-0.2	100	100	100	99
	16	Mg-0.5	Na-0.5	100	100	100	98
	17	Mg-0.5	Rb-1.0	100	100	100	98
	18	Mg-0.2	Cs-1.0	100	100	100	100
	19	Be-1.0	Na-1.0	100	100	100	96
	20	Sr-0.5	Na-1.0	100	100	100	99

Table 6-3

Catalyst	Amount of copper (mg-atom/g)	Kind and amount of alkaline earth metal (mg-atom/g)	Kind and amount of alkali metal or third metal (mg-atom/g)	Percent removal of COS at the time point shown below (%)				
				25hrs. later	50hrs. later	75hrs. later	100hrs. later	
Present invention	21	1.0	Ba-0.5	Na-1.0	100	100	100	95
	22	1.0	Mg-1.0	Pb-1.0	100	100	100	85
	23	1.0	Mg-1.0	Ti-1.0	100	100	100	59
	24	1.0	Mg-0.5	Al-0.5	100	100	99	60
	25	1.0	Mg-0.5	Cr-0.5	100	100	100	75
	26	1.0	Mg-0.5	Mn-0.5	100	100	94	70
	27	1.0	Mg-0.5	Fe-0.5	100	100	90	75
	28	1.0	Mg-0.5	Co-0.5	100	100	99	70
	29	1.0	Mg-0.5	Ni-0.5	100	100	98	53
	30	1.0	Mg-0.5	Zn-0.5	100	100	100	98
	31	1.0	Mg-0.5	Cd-0.5	100	100	90	63
	32	1.0	Mg-0.5	Pb-0.5	100	100	100	53
	33	1.0	Mg-0.5	Ti-0.5	100	100	91	41
	34	1.0	Mg-0.5	V -0.5	100	100	95	48

20

Table 6-4

Catalyst	Amount of copper (mg-atom/g)	Kind and amount of alkaline earth metal (mg-atom/g)	Kind and amount of alkali metal or third metal (mg-atom/g)	Percent removal of COS at the time point shown below (%)			
				25hrs. later	50hrs. later	75hrs. later	100hrs. later
Present invention	35	Ca-0.5	Al-0.5	100	100	98	70
	36	Ca-0.5	Cr-0.5	100	100	100	64
	37	Ca-0.5	Zn-0.5	100	100	100	92
	38	Ca-0.5	Pb-0.5	100	100	100	70
	39	Ca-0.5	Cd-0.5	100	100	100	75
	40	Be-0.5	Al-0.5	100	100	81	38
	41	Be-0.5	Cr-0.5	100	100	94	54
	42	Sr-0.5	Zn-0.5	100	100	100	90
	43	Sr-0.5	Cd-0.5	100	100	92	50
	44	Ba-0.5	V -0.5	100	100	100	69
	45	Ba-0.5	Ti-0.5	100	100	85	41
	46	Ca-1.0	Al-0.5	100	100	88	40
	47	Ca-1.0	Al-0.5	100	100	85	71

Table 7-1

Catalyst	Percent removal of H ₂ S at the time point shown below (%)						
	50hrs. later	100hrs. later	150hrs. later	200hrs. later	250hrs. later		
5	control	a	0	0	0	0	
		b	100	79	39	13	0
		c	95	32	0	0	0
10		d	100	58	5	0	0
		e	100	69	15	0	0
		f	100	30	0	0	0
		g	100	45	11	0	0
15		h	100	25	0	0	0
		i	100	64	14	0	0
		j	100	48	6	0	0
20	present invention	1	100	100	98	69	39
		2	100	100	100	95	83
		3	100	100	100	95	86
		4	100	100	100	100	98
25		5	100	100	90	81	65
		6	100	100	98	93	86
		7	100	100	90	83	69
		8	100	100	98	81	73
30		9	100	100	100	95	89
		10	100	100	99	98	84
		11	100	100	100	100	98
		12	100	100	100	100	98
35		13	100	100	100	100	100

Table 7-2

Catalyst		Percent removal of H ₂ S at the time point shown below (%)				
		50hrs. later	100hrs. later	150hrs. later	200hrs. later	250hrs. later
5	present invention	14	100	100	100	100
		15	100	100	100	100
		16	100	100	100	100
		17	100	100	100	100
		18	100	100	100	99
		19	100	100	100	100
		20	100	100	100	100
		21	100	100	100	100
		22	100	100	95	89
		23	100	100	91	85
		24	100	100	100	90
		25	100	100	100	98
		26	100	100	100	95
		27	100	100	100	98
		28	100	100	95	80
		29	100	100	91	78
		30	100	100	100	100
		31	100	100	100	100
		32	100	100	100	100
		33	100	100	95	81
		34	100	100	100	100
		35	100	100	100	98
		36	100	100	100	100
		37	100	100	100	100

Table 7-3

Catalyst	Percent removal of H ₂ S at the time point shown below (%)				
	50hrs. later	100hrs. later	150hrs. later	200hrs. later	250hrs. later
present invention	38	100	100	100	83
	39	100	100	100	86
	40	100	100	100	98
	41	100	100	100	92
	42	100	100	100	100
	43	100	100	100	100
	44	100	100	100	100
	45	100	100	100	98
	46	100	100	100	86
	47	100	100	100	94

Table 8-1

Catalyst	BET specific surface area (m ² /g)	Kind of alkaline earth metal salt and amount alkaline earth metal (mg-atom/g)	Kind of third metal compound or alkali metal compound and amount of the metal (mg-atom/g)	Amount of copper compound (as metal) (mg-atom/g)	Percent removal of COS at the time point shown below (%)		
					25hrs. later	50hrs. later	75hrs. later
48	1100	Be(NO ₃) ₂ -1.0	-	CuO - 0.89	100	95	76
49	1060	Mg(NO ₃) ₂ -1.0	-	CuSO ₄ -0.98	100	100	80
50	980	Ca(NO ₃) ₂ -1.0	-	(CH ₃ COO) ₂ Cu -1.03	100	100	83
51	1000	Sr(NO ₃) ₂ -1.0	-	(HCOO) ₂ Cu- 0.94	100	100	86
52	970	Ba(NO ₃) ₂ -1.0	-	CuCl ₂ -1.07	100	93	61
53	980	BeCO ₃ -0.95	-	(CH ₃ COO) ₂ Cu -1.0	100	93	58
54	1110	MgO-0.83	-	" 1.0	100	100	75
55	960	CaO-0.91	-	" 1.0	100	98	56
56	1050	SrO-1.05	-	" 1.0	100	100	90
57	1140	Ba(OH) ₂ -0.98	-	" 1.0	100	90	64
58	1000	MgCl ₂ -1.09	-	" 1.0	100	93	70
59	1060	(CH ₃ COO) ₂ Mg- 0.94	-	" 1.0	100	99	85

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Table 8-2

Catalyst	BET specific surface area (m ² /g)	Kind of alkaline earth metal salt and amount alkaline earth metal (mg-atom/g)	Kind of third metal compound or alkali metal compound and amount of the metal (mg-atom/g)	Amount of copper compound (as metal) (mg-atom/g)	Percent removal of COS at the time point shown below (%)			
					25hrs. later	50hrs. later	75hrs. later	100hrs. later
60	990	(HCOO) ₂ Ca-0.87	-	(CH ₃ COO) ₂ Cu -1.0	100	98	71	43
61	1120	BaCO ₃ -0.95	LiCO ₃ -0.85	"	100	100	91	25
62	1110	SrCO ₃ -0.82	Na ₂ SO ₄ -0.93	"	100	100	90	42
63	980	BeCO ₃ -0.99	K ₂ SO ₄ -0.88	"	100	100	95	53
64	980	MgCO ₃ -0.92	Rb ₂ SO ₄ -1.01	"	100	100	100	65
65	960	(CH ₃ COO) ₂ Sr- 0.83	Ca ₂ SO ₄ -1.00	"	100	100	89	31
66	1100	MgCO ₃ -0.92	HCOONa-1.09	"	100	100	96	45
67	1030	(HCOO) ₂ Mg -1.04	CH ₃ COOK-1.10	"	100	100	100	79
68	1010	CaCO ₃ -1.00	(COONa) ₂ -0.90	"	100	95	81	13
69	980	BeCO ₃ -0.95	Al(NO ₃) ₃ -0.5	"	100	98	85	49
70	1110	MgO-0.83	Cr(NO ₃) ₃ -0.5	"	100	100	87	58
71	960	CaCO ₃ -0.91	Mn(NO ₃) ₂ -0.5	"	100	100	93	60

Table 8-3

Catalyst	BET specific surface area (m ² /g)	Kind of alkaline earth metal salt and amount alkaline earth metal (mg-atom/g)	Kind of third metal compound or alkali metal compound and amount of the metal (mg-atom/g)	Amount of copper compound (as metal) (mg-atom/g)	Percent removal of COS at the time point shown below (%)			
					25hrs. later	50hrs. later	75hrs. later	100hrs. later
72	1050	SrO-1.05	Fe(NO ₃) ₃ -0.5	(CH ₃ COO) ₂ Cu -1.0	100	100	91	75
73	1140	Ba(OH) ₂ -0.98	Co(NO ₃) ₂ -0.5	" 1.0	100	100	78	53
74	1000	MgCl ₂ -1.09	Ni(NO ₃) ₂ -0.5	" 1.0	100	99	73	61
75	1060	(CH ₃ COO) ₂ Mg -0.94	Zn(NO ₃) ₂ -0.5	" 1.0	100	100	100	100
76	990	(HCOO) ₂ Ca-0.87	VOSO ₄ -0.5	" 1.0	100	100	95	88

Table 9-1

	Contacting temperature (°C)	Catalyst	Percent removal of COS at the time point shown below (%)			
			25hrs. later	50hrs. later	75hrs. later	100hrs. later
5	25	3	100	97	83	69
		9	100	94	80	65
10	60	3	100	100	100	64
		9	100	100	100	51
	80	3	100	100	100	86
		9	100	100	100	73
15	120	3	100	100	100	52
		9	100	100	100	35

Table 9-2

	Contacting temperature (°C)	Catalyst	Percent removal of COS at the time point shown below (%)			
			25hrs. later	50hrs. later	75hrs. later	100hrs. later
20	25	13	100	100	98	95
		20	100	100	97	92
25	60	13	100	100	100	100
		20	100	100	100	100
30	80	13	100	100	100	100
		20	100	100	100	100
	120	13	100	100	100	75
		20	100	100	100	61

Table 9-3

	Contacting temperature (°C)	Catalyst	Percent removal of COS at the time point shown below (%)			
			25hrs. later	50hrs. later	75hrs. later	100hrs. later
5	25	30	100	100	95	88
		37	100	100	100	95
10	60	30	100	100	100	69
		37	100	100	100	100
	80	30	100	100	100	78
		37	100	100	100	100
15	120	30	100	100	100	51
		37	100	100	100	68

Example 10

20 The activated carbon A of 16 to 24 mesh through having a B.E.T. specific surface area of 1065 m²/g was sprayed evenly with a solution in water of the determined amount each of copper nitrate, nitrate of an alkali metal and nitrate of Al, Cr, Mn, Fe, Co, Ni, Zn, Cd or Pb, 25 titanium sulfate or vanadium sulfate.

50 ml of the resultant admixed product was packed into a 4-cm ø column made of quartz glass. The column was heated at a heating rate of 5 °C/min. while a nitrogen gas was allowed to pass through it at a linear flow rate of 30 10 cm/sec., and the packed product was calcined at 300°C for 30 minutes.

The content each of the copper compound, alkali metal compound and the compounds of Al, Cr, Mn, Fe, Co, Ni, Zn, Cd, Pb, Ti and V in the catalysts thus obtained 35 were 0.2 to 2.0 mg atom as metal per g of activated carbon, as shown in Table 10.

40

As the control reference, the activated carbon was admixed by the same procedure as mentioned above with combinations of nitrate of an alkali

metal and a compound of Al, Cr, Mn, Fe, Co, Ni, Zn, Cd, Pb, Ti or V, and the admixed product was calcined in a nitrogen gas at 300°C for 30 minutes. By this procedure, catalysts E₁ to E₅ were prepared.

15 ml each of the catalysts (E) through (M) thus obtained was packed into a 1.6 cm ϕ glass column, and a gas of 50°C containing 12.5 ppm of COS (N₂-97.5 vol.% and H₂O-2.5 vol.%) was passed through it at a linear flow rate of 40 cm/sec to conduct a break-through adsorption test on COS. The results are as shown in Table 10.

15

Example 11

A 12 ml portion each of the catalysts (E) through (M) of Example 10 was packed into a 1.6 cm ϕ glass column, and a gas at 25°C containing 10 ppm of H₂S (N₂-97.5 vol.% and H₂O-2.5 vol.%) was passed through it at a linear flow rate of 40 cm/sec to conduct a break-through adhesion test on H₂S. The results are as shown in Table 11.

20

Example 12

The determined amount of each of Li₂CO₃, Na₂SO₄, K₂SO₄, Rb₂SO₄, Cs₂SO₄, HCOONa, CH₃COOK and (COONa)₂ was added to a coconut-shell raw material. After being mixed and crushed, the mixture was kneaded with various kinds of pitch, water, etc., and molded into cylindrical pellets of 4 mm ϕ . The pellets were carbonized at 650°C and steam-activated at 900°C.

30

The activated carbons thus obtained all showed a B.E.T. specific surface area of 950 to 1150 m²/g and a content of an alkali metal compound of 0.4 to 0.6 mg atom as metal per g of activated carbon, as shown in Table 12.

35

Various kinds of the activated carbon were crushed and sieved to a uniform grain size of 16 to 24 mesh through,

and each sprayed with a solution in a 2% aqueous nitric acid of the determined amount each of copper nitrate and nitrate of Al, Cr, Mn, Fe, Co, Ni, Zn, Cd or Pb, titanium sulfate or vanadyl sulfate.

5 50 ml each of the admixed products thus obtained was packed into a 4-cm ϕ column made of quartz glass. The column was heated at a heating rate of 5 °C/min, while a nitrogen gas was allowed to pass through it at a linear flow rate of 10 cm/sec., and the packed product was calcined at
10 350°C for 30 minutes. The content of the copper compound in the resultant catalysts was 1.0 mg atom as metal per g of activated carbon, while the contents of the compounds of Al, Cr, Mn, Fe, Co, Ni, Zn, Cd, Pb, Ti and V were 0.5 mg atom as metal per g of activated carbon.

15 15 ml each of the catalysts (N) through (U) thus obtained was packed into a 1.6 cm ϕ glass column, and a gas ^{at} 40°C containing 12.5 ppm of COS (N₂-97.5 vol.% and H₂O-2.5 vol.%) was passed through to conduct a break-through adsorption test on COS. The results are as shown in Table 12.

20

Example 13

A 15 ml portion each of the catalysts (G₇) and (H₃) of Example 10 was packed into a 1.6-cm ϕ glass column, and a gas containing 12.5 ppm of COS (N₂-97.5 vol.% and H₂O-2.5
25 vol.%) was passed through the column at 25, 60, 80 and 120°C, respectively, to conduct break-through adsorption tests on COS, whereby the gas linear flow rate in every case was maintained at 40 cm/sec as measured at 25°C. The test results are as shown in Table 13.

Table 10-1

Catalyst	Amount of copper (mg-atom/g)	Kind and amount of alkali metal (mg-atom/g)	Kind and amount of third metals (mg-atom/g)	Percent removal of COS at the time point shown below (%)			
				25hrs. later	50hrs. later	75hrs. later	100hrs. later
(E ₁) (control)	0	Na-1.0	Al-1.0	49	4	0	0
(E ₂) "	0	Na-1.0	Cr-1.0	68	15	0	0
(E ₃) "	0	Na-1.0	Fe-1.0	51	18	3	0
(E ₄) "	0	Na-1.0	Zn-1.0	100	60	26	11
(E ₅) "	0	Na-1.0	Cd-1.0	100	55	13	0
(F ₁) (present invention)	1.0	Na-1.0	Pb-1.0	100	100	100	77
(F ₂) "	1.0	Na-1.0	Ti-1.0	100	100	100	69
(G ₁) "	1.0	Na-0.5	Al-0.5	100	100	98	68
(G ₂) "	1.0	Na-0.5	Cr-0.5	100	100	100	73
(G ₃) "	1.0	Na-0.5	Mn-0.5	100	100	95	63
(G ₄) "	1.0	Na-0.5	Fe-0.5	100	100	95	79
(G ₅) "	1.0	Na-0.5	Co-0.5	100	100	98	53
(G ₆) "	1.0	Na-0.5	Ni-0.5	100	100	96	49
(G ₇) "	1.0	Na-0.5	Zn-0.5	100	100	100	70

Table 10-2

Catalyst	Amount of copper (mg-atom/g)	Kind and amount of alkali metal (mg-atom/g)	Kind and amount of third metals (mg-atom/g)	Percent removal of COS at the time point shown below (%)			
				25hrs. later	50hrs. later	75hrs. later	100hrs. later
Gg(present invention)	1.0	Na-0.5	Cd-0.5	100	100	96	56
G9(")	1.0	Na-0.5	Pb-0.5	100	100	100	60
G10(")	1.0	Na-0.5	Ti-0.5	100	100	93	48
G11(")	1.0	Na-0.5	V -0.5	100	100	98	58
H1X(")	1.0	K -0.5	Al-0.5	100	100	100	73
H2X(")	1.0	K -0.5	Cr-0.5	100	100	100	61
H3X(")	1.0	K -0.5	Zn-0.5	100	100	100	88
H4X(")	1.0	K -0.5	Pb-0.5	100	100	100	69
H5X(")	1.0	K -0.5	Cd-0.5	100	100	100	78
I1X(")	1.0	Li-0.5	Al-0.5	100	100	95	59
I2X(")	1.0	Li-0.5	Cr-0.5	100	100	98	63
J1X(")	1.0	Rb-0.5	Zn-0.5	100	100	100	89
J2X(")	1.0	Rb-0.5	Cd-0.5	100	100	97	54
K1X(")	1.0	Cs-0.5	V -0.5	100	100	100	78

Table 10-3

Catalyst	Amount of copper (mg-atom/g)	Kind and amount of alkali metal (mg-atom/g)	Kind and amount of third metals (mg-atom/g)	Percent removal of COS at the time point shown below (%)			
				25hrs. later	50hrs. later	75hrs. later	100hrs. later
(K ₂) (present invention)	1.0	Cs-0.5	Ti-0.5	100	100	94	53
(L) (")	0.2	K -1.0	Al-0.5	100	100	90	40
(M) (")	0.5	K -1.0	Al-0.5	100	100	95	77

Table 11-1

	Catalyst	Percent removal of H ₂ S at the time point shown below (%)				
		50hrs. later	100hrs. later	150hrs. later	200hrs. later	250hrs. later
5	(E ₁) (control)	100	48	12	0	0
	(E ₂) (")	100	69	18	0	0
	(E ₃) (")	100	54	4	0	0
10	(E ₄) (")	100	72	24	0	0
	(E ₅) (")	100	60	13	0	0
	(F ₁) (present invention)	100	100	100	98	90
	(F ₂) (")	100	100	100	95	90
15	(G ₁) (")	100	100	100	99	94
	(G ₂) (")	100	100	100	100	92
	(G ₃) (")	100	100	100	100	90
20	(G ₄) (")	100	100	100	100	94
	(G ₅) (")	100	100	100	98	85
	(G ₆) (")	100	100	100	98	89
	(G ₇) (")	100	100	100	100	91
25	(G ₈) (")	100	100	100	100	100
	(G ₉) (")	100	100	100	100	100
	(G ₁₀) (")	100	100	100	98	91
	(G ₁₁) (")	100	100	100	100	100
30	(H ₁) (")	100	100	100	100	95
	(H ₂) (")	100	100	100	100	100
	(H ₃) (")	100	100	100	100	100
	(H ₄) (")	100	100	100	100	94
35	(H ₅) (")	100	100	100	100	96
	(I ₁) (")	100	100	100	95	91

Table 11-2

Catalyst	Percent removal of H ₂ S at the time point shown below (%)				
	25hrs. later	100hrs. later	150hrs. later	200hrs. later	250hrs. later
5 (I ₂) (present invention)	100	100	100	98	92
(J ₁) (")	100	100	100	100	100
(J ₂) (")	100	100	100	100	100
10 (K ₁) (")	100	100	100	100	100
(K ₂) (")	100	100	100	99	96
(L) (")	100	100	100	92	85
15 (M) (")	100	100	100	93	90

Table 12

Catalyst	B.E.T specific surface area (m ² /g)	Kind of alkali metal salt incorporated and amount of alkali metal (mg-atom/g)	Amount of copper (mg-atom/g)	Kind and amount of third metal	Percent removal of COS at the time point shown below (%)			
					25hrs. later	50hrs. later	75hrs. later	100hrs. later
(N)	1100	Li ₂ CO ₃ -0.45	1.0	Al-0.5	100	100	93	48
(O)	1050	Na ₂ SO ₄ -0.49	1.0	Cr-0.5	100	100	98	65
(P)	980	K ₂ SO ₄ -0.48	1.0	Mn-0.5	100	100	95	60
(Q)	1000	Rb ₂ SO ₄ -0.51	1.0	Fe-0.5	100	100	93	63
(R)	1000	Cs ₂ SO ₄ -0.55	1.0	Co-0.5	100	100	100	68
(S)	960	HCOONa-0.46	1.0	Ni-0.5	100	100	96	55
(T)	1080	CH ₃ COOK-0.50	1.0	Zn-0.5	100	100	100	56
(U)	1100	(COONa) ₂ -0.52	1.0	V -0.5	100	100	100	49

Table 13

	Contacting temperature	Catalyst	Percent removal of COS at the time point shown below (%)			
			25hrs. later	50hrs. later	75hrs. later	100hrs. later
5	25	G7	100	100	90	85
		H ₃	100	100	100	92
10	60	G7	100	100	100	58
		H ₃	100	100	100	100
	80	G7	100	100	100	59
		H ₃	100	100	100	100
15	120	G7	100	100	100	46
		H ₃	100	100	100	65



Claims

1. A process for treatment of a gas containing hydrogen sulfide and/or carbonyl sulfide but not substantially containing oxygen, which comprises contacting the gas with activated carbon containing (1) a copper compound and (2) an alkali metal compound and/or an alkaline earth metal compound at a temperature of not higher than 150°C, whereby hydrogen sulfide and/or carbonyl sulfide are removed from the gas.
2. A process as claimed in claim 1, wherein the activated carbon is one containing a copper compound and an alkali metal compound.
3. A process as claimed in claim 1, wherein the activated carbon is one containing a copper compound and an alkaline earth metal compound.
4. A process as claimed in claim 1, wherein the activated carbon is one containing a copper compound, an alkali metal compound and an alkaline earth metal compound.
5. A process as claimed in claim 1, wherein the activated carbon is one containing a compound of at least one kind of metal selected from the group consisting of Al, Ti, V, Cr, Mn, Fe, Co, Ni, Zn, Cd and Pb as a third component, together with a copper compound and an alkali metal compound and/or alkaline earth metal compound.
6. A process as claimed in claim 5, wherein the activated carbon is one containing a copper compound, an alkali metal compound and a compound of at least one kind of metal selected from the group consisting of Al, Ti, V, Cr, Mn, Fe, Co, Ni, Zn, Cd and Pb.



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7. A process as claimed in claim 5, wherein the activated carbon is one containing a copper compound, alkaline earth metal compound and a compound of at least one kind of metal selected from the group consisting of Al, Ti, V, Cr, Mn, Fe, Co, Ni, Zn, Cd and Pb.

8. A process as claimed in claim 1, wherein the gas not containing substantially oxygen is that having an oxygen concentration of not more than 2 vol %.

9. A process as claimed in claim 1, wherein the gas is contacted with the activated carbon containing metal compounds at a temperature of 0°C to 150°C.

10. A process as claimed in claim 1, wherein the gas is contacted with the activated carbon containing metal compound for 1/10 to 100 seconds as measured at 25°C and 1 kg/cm².

11. An activated carbon containing (1) a copper compound and (2) an alkali metal compound and/or an alkaline earth metal compound when used for the treatment of a gas containing hydrogen sulfide and/or carbonyl sulfide but not substantially containing oxygen by contacting the activated carbon with the gas at a temperature of not higher than 150°C.

12. A process according to claim 1, substantially as hereinbefore with reference to any of the Examples.

13. An activated carbon according to claim 11, substantially as hereinbefore described with reference to any of the Examples.