SNCR is the use of reductants and catalysts, as well as the cost of equipment, energy, or the like for such treatment.

[0005] To address these problems, the present inventors proposed an efficient and less expensive method for treating the acidic exhaust gas by using carbonate-type Mg-Al layered double hydroxide (see PTL1).

Citation List

Patent Literature

[0006] PTL1: JP 2016190199 A

Summary

Technical Problem

[0007] However, even by the treatment method described in PTL1, the removal treatment of nitric oxide was not always sufficient.

Therefore, in the treatment of acidic exhaust gas using layered double hydroxide, there has been a need to improve the efficiency in removing nitric oxide.

[0008] The present disclosure has been developed under these circumstances, and an object thereof is to provide an acidic exhaust gas treatment agent, an acidic exhaust gas treatment method, and acidic exhaust gas treatment equipment that can enhance the efficiency in removing nitric oxide more than before when treating acidic exhaust gas generated from combustion facilities such as thermal power plants and incineration facilities by using layered double hydroxide.

Solution to Problem

[0009] The present disclosure is based on the finding that a complex of Mg-Al layered double hydroxide (hereinafter, also referred to as Mg-Al LDH) with manganese oxide or the like delivers excellent performance in removing nitric oxide. In one aspect, the present disclosure refers to an acidic exhaust gas treatment agent comprising a complex of at least one of compounds of represented by the following formulae (1) and (2):

$$Mg_{1-x}Al_x(OH)_2(MnO_2)_{2.5x}(Cl)_x \cdot mH_2O \quad (1)$$

$$Mg_{1-x}Al_x(OH)_2(MnO_4)_x \cdot mH_2O \quad (2)$$

wherein, x = 0.20 to 0.40, and m = 1 to 12.

[0009a] In another aspect, the present disclosure refers to a method for treating acidic exhaust gas by using the acidic exhaust gas treatment agent disclosed herein, the method comprising the steps of: (1) bringing the acidic exhaust gas into contact with the acidic exhaust gas treatment agent to adsorb an acidic substance in the acidic exhaust gas; (2) desorbing the acidic substance adsorbed on the acidic exhaust gas treatment agent in step (1) to regenerate the acidic exhaust gas treatment agent; and (3) recovering the acidic substance desorbed from the acidic exhaust gas treatment agent in step (2).

[0009b] In yet another aspect, the present disclosure refers to equipment for treating acidic exhaust gas by using the acidic exhaust gas treatment agent as disclosed herein, the equipment comprising: means (1) for bringing the acidic exhaust gas into contact with the acidic exhaust gas treatment agent to adsorb an acidic substance in the acidic exhaust gas; means (2) for desorbing the acidic substance adsorbed on the acidic exhaust gas treatment agent in means (1) to regenerate the acidic exhaust gas treatment agent; and means (3) for recovering the acidic substance desorbed from the acidic exhaust gas treatment agent in means (2).

[0010] In some examples, the present disclosure provides the following [1] to [7].

[1] An acidic exhaust gas treatment agent comprising a complex of Mg-Al layered double hydroxide with at least one of manganese oxide and a permanganate compound.

[2] The acidic exhaust gas treatment agent according to [1], wherein the complex is at least one of manganese dioxide-composite Mg-Al layered double hydroxide and permanganate-type Mg-Al layered double hydroxide.

[3] The acidic exhaust gas treatment agent according to [1] or [2], comprising carbonate-type Mg-Al layered double hydroxide.

[0011] [4] A method for treating acidic exhaust gas by using the acidic exhaust gas treatment agent according to any one of [1] to [3], the method comprising the steps of: (1) bringing the acidic exhaust gas into contact with the acidic exhaust gas treatment agent to adsorb an acidic substance in the acidic exhaust gas; (2) desorbing the acidic substance adsorbed on the acidic exhaust gas treatment agent in step (1) to regenerate the acidic exhaust gas treatment agent; and (3)

recovering the acidic substance desorbed from the acidic exhaust gas treatment agent in step (2).

[5] The method according to [4], wherein a treatment cycle comprising steps (1) to (3) is repeatedly performed, and in step (1) of at least one of the treatment cycles after the second treatment cycle, the acidic exhaust gas treatment agent regenerated in step (2) of at least one of the treatment cycles before the treatment cycle is used for at least part of the acidic exhaust gas treatment agent.

[0012] [6] Equipment for treating acidic exhaust gas by using the acidic exhaust gas treatment agent according to any one of [1] to [3], the equipment comprising: means (1) for bringing the acidic exhaust gas into contact with the acidic exhaust gas treatment agent to adsorb an acidic substance in the acidic exhaust gas; means (2) for desorbing the acidic substance adsorbed on the acidic exhaust gas treatment agent in means (1) to regenerate the acidic exhaust gas treatment agent; and means (3) for recovering the acidic substance desorbed from the acidic exhaust gas treatment agent in means (2).

[7] The method according to [4], wherein the manganese dioxide-composite Mg-Al layered double hydroxide is produced, without requiring a reduction process, by adding Mg-Al oxide to a potassium permanganate aqueous solution, filtering the resulting mixture to obtain a precipitate, and drying the precipitate.

Advantageous Effects of the present disclosures

[0013] The use of the acidic exhaust gas treatment agent of the present disclosures makes it possible to remove and treat acidic exhaust gases simultaneously, the acidic exhaust gases including hydrogen chloride, sulfur oxides, and nitrogen oxides and generated from combustion facilities such as thermal power plants and incineration facilities. In particular, the use of the acidic exhaust gas treatment agent of the present disclosures achieves more improved efficiency in removing nitric oxide than the use of conventional layered double hydroxides.

According to the acidic exhaust gas treatment method of the present disclosures using the acidic exhaust gas treatment agent, acidic exhaust gas can be efficiently removed with a smaller amount of treatment agent than before, and the acidic exhaust gas treatment agent can also be recycled.

In addition, by using the acidic exhaust gas treatment equipment of the present disclosures, the acidic exhaust gas treatment method can be suitably performed, and thus it is possible to treat acidic exhaust gas more efficiently and at lower cost than before.

Brief Description of Drawings

[0014] [Fig. 1] Fig. 1 is a graph showing changes with time in a NO_x concentration of a gas at the outlet of a reaction tube in the test for evaluating the performance in acidic exhaust gas treatment in Examples.

[Fig. 2] Fig. 2 is a powder X-ray diffraction diagram of a product in Synthesis Example 1.

[Fig. 3] Fig. 3 is a powder X-ray diffraction diagram of a product in Synthesis Example 2.

[Fig. 4] Fig. 4 is a powder X-ray diffraction diagram of CO_3-type Mg-Al LDH.

[Fig. 5] Fig. 5 is a XPS spectrum of a product in Synthesis Example 1.

[Fig. 6] Fig. 6 is a XPS spectrum of a product in Synthesis Example 2.

Description of Embodiments

[0015] The acidic exhaust gas treatment agent of the present invention, and the acidic exhaust gas treatment method and an acidic exhaust gas treatment equipment using the treatment agent will be described in detail below.

[0016] [Acidic exhaust gas treatment agent]

The acidic exhaust gas treatment agent of the present invention comprises a complex of Mg-Al LDH with at least one of manganese oxide and a permanganate compound (hereinafter, also referred to as a Mn-O compound).

CLAIMS

[Claim 1]

An acidic exhaust gas treatment agent comprising a complex of at least one of compounds of represented by the following formulae (1) and (2):

$Mg_{1-x}Al_x(OH)_2(MnO_2)_{2.5x}(Cl)_x \cdot mH_2O$ (1)

$Mg_{1-x}Al_x(OH)_2(MnO_4)_x \cdot mH_2O$ (2)

wherein, x = 0.20 to 0.40, and m = 1 to 12.

[Claim 2]

The acidic exhaust gas treatment agent according to claim 1, comprising carbonate-type Mg-Al layered double hydroxide.

[Claim 3]

A method for treating acidic exhaust gas by using the acidic exhaust gas treatment agent according to any one of claim 1 or 2, the method comprising the steps of:

(1) bringing the acidic exhaust gas into contact with the acidic exhaust gas treatment agent to adsorb an acidic substance in the acidic exhaust gas;

(2) desorbing the acidic substance adsorbed on the acidic exhaust gas treatment agent in step (1) to regenerate the acidic exhaust gas treatment agent; and

(3) recovering the acidic substance desorbed from the acidic exhaust gas treatment agent in step (2).

[Claim 4]

The method according to claim 3, wherein a treatment cycle comprising steps (1) to (3) is repeatedly performed, and in step (1) of at least one of the treatment cycles after the second treatment cycle, the acidic exhaust gas treatment agent regenerated in step (2) of at least one of the treatment cycles before the treatment cycle is used for at least part of the acidic exhaust gas treatment agent.

[Claim 5]

Equipment for treating acidic exhaust gas by using the acidic exhaust gas treatment agent according to any one of claim 1 or 2, the equipment comprising:

means (1) for bringing the acidic exhaust gas into contact with the acidic exhaust gas treatment agent to adsorb an acidic substance in the acidic exhaust gas;

means (2) for desorbing the acidic substance adsorbed on the acidic exhaust

gas treatment agent in means (1) to regenerate the acidic exhaust gas treatment agent; and

means (3) for recovering the acidic substance desorbed from the acidic exhaust gas treatment agent in means (2).

[Claim 6]

The method according to claim 3, wherein the manganese dioxide-composite Mg-Al layered double hydroxide is produced, without requiring a reduction process, by adding Mg-Al oxide to a potassium permanganate aqueous solution, filtering the resulting mixture to obtain a precipitate, and drying the precipitate.