PRIOR ART DOCUMENT

PATENT DOCUMENT

[0004]

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SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0005]

An object of the present invention is to provide a carbon dioxide emission reduction method and a carbon dioxide emission reduction system capable of effectively reducing carbon dioxide contained in exhaust gas discharged from an internal combustion engine.

MEANS FOR SOLVING THE PROBLEM

[0006]

According to a first aspect of the invention, there is provided a carbon dioxide emission reduction method comprising: reducing carbon dioxide contained in exhaust gas discharged from an internal combustion engine by injecting the exhaust gas into an alkaline solution stored in a storage tank, thereby bringing the alkaline solution and the exhaust gas into contact with each other inside the storage tank, and causing a neutralization reaction between the alkaline solution and carbon dioxide contained in the exhaust gas; and discharging the exhaust gas with the carbon dioxide reduced from an exhaust port of the storage tank, wherein a plurality of ejection nozzles configured to be supplied with the exhaust gas are installed at a lower portion inside the storage tank, and the exhaust gas is ejected from each of the ejection nozzles while supplying the alkaline solution from a solution supply line to

an inflow port provided at a lower portion of the storage tank, thereby generating a spiral flow in which numerous bubbles of the exhaust gas spirally rise in the alkaline solution inside the storage tank, and the alkaline solution after the neutralization reaction is discharged from a drain port provided at an upper portion of the storage tank.

[0006a]

According to a second aspect of the invention, there is provided a carbon dioxide emission reduction method comprising: reducing carbon dioxide contained in exhaust gas discharged from an internal combustion engine by injecting the exhaust gas into an alkaline solution stored in a storage tank, thereby bringing the alkaline solution and the exhaust gas into contact with each other inside the storage tank, and causing a neutralization reaction between the alkaline solution and the carbon dioxide contained in the exhaust gas; and discharging the exhaust gas with the carbon dioxide reduced from an exhaust port of the storage tank, wherein a plurality of the storage tanks are connected in series via a vent pipe through which the exhaust gas flows and a connecting pipe through which the alkaline solution flows, the alkaline solution which is stored in the upstream storage tank and which has a hydrogen ion concentration reduced by the neutralization reaction with the carbon dioxide contained in the exhaust gas is discharged from a drain port of the upstream storage tank, the alkaline solution discharged from the drain port flows into the downstream storage tank through the connecting pipe and is stored in the downstream storage tank and the exhaust gas discharged from the exhaust port of the upstream storage tank is injected through the vent

pipe into the alkaline solution stored in the downstream storage tank, thereby bringing the alkaline solution and the exhaust gas into contact with each other inside the downstream storage tank to cause a neutralization reaction between the alkaline solution and the carbon dioxide contained in the exhaust gas, thereby further reducing the carbon dioxide contained in the exhaust gas and further reducing the hydrogen ion concentration in the alkaline solution, the exhaust gas with the carbon dioxide further reduced is discharged from the exhaust port of the downstream storage tank, the alkaline solution with the hydrogen ion concentration further reduced is discharged from the drain port of the downstream storage tank, and a precipitate generated by the neutralization reaction is discharged from a discharge port provided at a lower portion of each of the storage tanks to an outside of the storage tank.

[0006b]

According to a third aspect of the invention, there is provided a carbon dioxide emission reduction method comprising: reducing carbon dioxide contained in exhaust gas discharged from an internal combustion engine by injecting the exhaust gas into an alkaline solution stored in a storage tank, thereby bringing the alkaline solution and the exhaust gas into contact with each other inside the storage tank, and causing a neutralization reaction between the alkaline solution and the carbon dioxide contained in the exhaust gas; and discharging the exhaust gas with the carbon dioxide reduced from an exhaust port of the storage tank, wherein a raw water level adjustment tank is supplied with the alkaline solution obtained by removing, from the alkaline solution produced in a solution production

tank, a solid substance used to produce the alkaline solution, in a state in which the raw water level adjustment tank configured to temporarily store the produced alkaline solution is connected to the storage tank by a connecting pipe, the alkaline solution stored in the raw water level adjustment tank is caused to flow into the storage tank, so that a liquid level position of the alkaline solution stored in the raw water level adjustment tank and a liquid level position of the alkaline solution stored in the storage tank are set to the same height.

[0007]

According to a fourth aspect of the invention, there is provided a carbon dioxide emission reduction system comprising: a storage tank configured to store an alkaline solution; and

an injection instrument configured to inject exhaust gas discharged from an internal combustion engine into the alkaline solution stored in the storage tank, wherein the alkaline solution and the exhaust gas injected by the injection instrument are brought into contact with each other inside the storage tank to cause a neutralization reaction between the alkaline solution and carbon dioxide contained in the exhaust gas, thereby reducing the carbon dioxide contained in the exhaust gas, the exhaust gas with the carbon dioxide reduced is discharged from an exhaust port of the storage tank, a plurality of ejection nozzles configured to be supplied with the exhaust gas are installed at a lower portion inside the storage tank, while the alkaline solution is being supplied from a solution supply line to an inflow port provided at a lower portion of the storage tank, the exhaust gas is ejected from each of the ejection nozzles, thereby generating a spiral flow in which numerous bubbles of the exhaust gas spirally rise in the alkaline solution inside the storage tank, and the alkaline solution after the neutralization reaction is discharged from a drain port provided at an upper portion of the storage tank.

[0007a]

According to a fifth aspect of the invention, there is provided a carbon dioxide emission reduction system comprising: a storage tank configured to store an alkaline solution; and an injection instrument configured to inject exhaust gas discharged from an internal combustion engine into the alkaline solution stored in the storage tank, wherein the alkaline solution and the exhaust gas injected by the injection instrument are brought into contact with each other inside the

storage tank to cause a neutralization reaction between the alkaline solution and carbon dioxide contained in the exhaust gas, thereby reducing the carbon dioxide contained in the exhaust gas the exhaust gas with the carbon dioxide reduced is discharged from an exhaust port of the storage tank, a plurality of the storage tanks are connected in series via a vent pipe through which the exhaust gas flows and a connecting pipe through which the alkaline solution flows, the alkaline solution which is stored in the upstream storage tank and which has a hydrogen ion concentration reduced by the neutralization reaction with the carbon dioxide contained in the exhaust gas is discharged from a drain port of the upstream storage tank, the alkaline solution discharged from the drain port flows into the downstream storage tank through the connecting pipe and is stored in the downstream storage tank and the exhaust gas discharged from the exhaust port of the upstream storage tank is injected through the vent pipe into the alkaline solution stored in the downstream storage tank, thereby bringing the alkaline solution and the exhaust gas into contact with each other inside the downstream storage tank to cause a neutralization reaction between the alkaline solution and the carbon dioxide contained in the exhaust gas, thereby further reducing the carbon dioxide contained in the exhaust gas and further reducing the hydrogen ion concentration in the alkaline solution, the exhaust gas with the carbon dioxide further reduced is discharged from the exhaust port of the downstream storage tank, the alkaline solution with the hydrogen ion concentration further reduced is discharged from the drain port of the downstream storage tank, and

a precipitate generated by the neutralization reaction

is discharged from a discharge port provided at a lower portion of each of the storage tanks to an outside of the storage tank.

[0007b]

According to a sixth aspect of the invention, there is provided a carbon dioxide emission reduction system comprising: a storage tank configured to store an alkaline solution; and an injection instrument configured to inject exhaust gas discharged from an internal combustion engine into the alkaline solution stored in the storage tank, wherein the alkaline solution and the exhaust gas injected by the injection instrument are brought into contact with each other inside the storage tank to cause a neutralization reaction between the alkaline solution and carbon dioxide contained in the exhaust gas, thereby reducing the carbon dioxide contained in the exhaust gas, the exhaust gas with the carbon dioxide reduced is discharged from an exhaust port of the storage tank, a raw water level adjustment tank is supplied with the alkaline solution obtained by removing, from the alkaline solution produced in a solution production tank, a solid substance used to produce the alkaline solution, in a state in which the raw water level adjustment tank configured to temporarily store the produced alkaline solution is connected to the storage tank by a connecting pipe, the alkaline solution stored in the raw water level adjustment tank is caused to flow into the storage tank, so that a liquid level position of the alkaline solution stored in the raw water level adjustment tank and a liquid level position of the alkaline solution stored in the storage tank are adjusted to the same height.

[0007c]

According to a sixth aspect of the invention, there is provided a carbon dioxide emission reduction system comprising: a storage tank configured to store an alkaline solution; and an injection instrument configured to inject exhaust gas discharged from an internal combustion engine into the alkaline solution stored in the storage tank, wherein the alkaline solution and the exhaust gas injected by the injection instrument are brought into contact with each other inside the storage tank to cause a neutralization reaction between the alkaline solution and carbon dioxide contained in the exhaust gas, thereby reducing the carbon dioxide contained in the exhaust gas, the exhaust gas with the carbon dioxide reduced is discharged from an exhaust port of the storage tank, a plurality of the storage tanks are connected in series via a vent pipe through which the exhaust gas flows, and each of the plurality of the storage tanks includes a carbon dioxide meter configured to measure a carbon dioxide concentration in the exhaust gas with the carbon dioxide reduced.

[0007d]

According to a seventh aspect of the invention, there is provided a carbon dioxide emission reduction system comprising: a dust collecting device configured to remove dust from exhaust gas discharged by an internal combustion engine; a heat removal tank configured to remove heat from the exhaust gas with the dust removed; a storage tank configured to store an alkaline solution; and an injection instrument configured to inject the exhaust gas with the heat removed into the alkaline solution stored in the storage tank, wherein the alkaline solution and

the exhaust gas injected by the injection instrument are brought into contact with each other inside the storage tank to cause a neutralization reaction between the alkaline solution and carbon dioxide contained in the exhaust gas, thereby reducing the carbon dioxide contained in the exhaust gas, and the exhaust gas with the carbon dioxide reduced is discharged from an exhaust port of the storage tank.

[0007e]

According to an eighth aspect of the invention, there is provided a carbon dioxide emission reduction system comprising: a solution production tank configured to be supplied with recycled crushed stone and water and produce an alkaline solution by using a stirrer configured to stir the recycled crushed stone and the water; an adjustment tank including a hydrogen ion concentration meter and configured to be supplied with the alkaline solution from the solution production tank; a storage tank configured to be supplied with the alkaline solution from the adjustment tank via a connecting pipe and store the alkaline solution; and an injection instrument configured to inject exhaust gas discharged from an internal combustion engine into the alkaline solution stored in the storage tank, wherein the alkaline solution and the exhaust gas injected by the injection instrument are brought into contact with each other inside the storage tank to cause a neutralization reaction between the alkaline solution and carbon dioxide contained in the exhaust gas, thereby reducing the carbon dioxide contained in the exhaust gas, the exhaust gas with the carbon dioxide reduced is discharged from an exhaust port of the storage tank, the hydrogen ion concentration

meter measures a hydrogen ion concentration in the alkaline solution in the adjustment tank, and an amount of recycled crushed stone supplied to the solution production tank is adjusted based on the measurement result.

EFFECTS OF THE INVENTION

[0008]

According to the present invention, the carbon dioxide contained in the exhaust gas discharged from the internal combustion engine can be effectively reduced by injecting the exhaust gas discharged from the internal combustion engine into the alkaline solution stored in the storage tank and causing a neutralization reaction between the carbon dioxide contained in the exhaust and the alkaline solution inside the storage tank. Moreover, the alkaline solution used to reduce the carbon dioxide contained in the exhaust gas can be reduced in hydrogen ion concentration by causing the neutralization reaction with the carbon dioxide. Therefore, the alkaline solution can be also easily disposed of after use.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

[Fig. 1] Fig. 1 is an explanatory diagram schematically illustrating an embodiment of a carbon dioxide emission reduction system of the present invention.

[Fig. 2] Fig. 2 is an explanatory diagram schematically