Claims

[Claim 1]

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 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.

[Claim 2]

The carbon dioxide emission reduction method according to claim 1, wherein a protrusion which is provided on an inner surface of the storage tank so as to extend spirally and which

has no through-hole spirally guides the spiral flow, thereby lowering a rising speed of the bubbles of the exhaust gas rising in the alkaline solution.

[Claim 3]

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.

[Claim 4]

The carbon dioxide emission reduction method according to claim 3, wherein

a carbon dioxide concentration in the exhaust gas after the exhaust gas passes through the alkaline solution in each of the storage tanks is measured,

the exhaust gas whose carbon dioxide concentration is equal to or lower than a preset reference value is not injected into the alkaline solution stored in the downstream storage tank but is disposed of as treated exhaust gas.

[Claim 5]

The carbon dioxide emission reduction method according to claim 3 or 4, wherein

the hydrogen ion concentration in the alkaline solution stored in each of the storage tanks is measured,

the alkaline solution whose hydrogen ion concentration is equal to or lower than a preset threshold is not injected into the alkaline solution stored in the downstream storage tank but is disposed of as a treated solution.

[Claim 6]

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.

[Claim 7]

The carbon dioxide emission reduction method according to claim 6, wherein

a flow rate of the alkaline solution supplied to the raw water level adjustment tank is adjusted so that the liquid level position of the alkaline solution stored in the raw water level adjustment tank is kept at a preset certain height.

[Claim 8]

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.

[Claim 9]

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.

[Claim 10]

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.

[Claim 11]

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.

[Claim 12]

The carbon dioxide emission reduction system according to claim 11, wherein

the vent pipe connecting the plurality of the storage tanks includes a pressure meter configured to measure a pressure of the exhaust gas.

[Claim 13]

The carbon dioxide emission reduction system according to claim 11 or 12, wherein

each of the plurality of the storage tanks includes a hydrogen ion concentration meter configured to a hydrogen ion concentration in the alkaline solution.

[Claim 14]

The carbon dioxide emission reduction system according to any one of claims 11 to 13, comprising a management apparatus

to which part or all of measurement data measured by the carbon dioxide meter, the pressure meter, and the hydrogen ion concentration meter is transmitted.

[Claim 15]

The carbon dioxide emission reduction system according to any one of claims 11 to 14, wherein

each of the plurality of the storage tanks includes a discharge pipe configured to discharge a precipitate generated by the neutralization reaction and a discharge valve configured to open and close the discharge pipe.

[Claim 16]

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.

[Claim 17]

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.