Claims

[Claim 1]

An apparatus for direct decomposition of a hydrocarbon, which directly decomposes a hydrocarbon into carbon and hydrogen using a gas containing methane and a hydrocarbon having two or more carbon atoms as a raw material gas, the apparatus comprising:

a reformer that houses a first catalyst for methanation of the hydrocarbon having two or more carbon atoms;

a reactor which is configured so that a reformed gas flowing out of the reformer flows into the reactor, and which houses a second catalyst that is an iron-based catalyst; and

a recycling line that connects a produced gas line through which a produced gas flowing out of the reactor flows, to a raw material gas line for introducing the raw material gas into the reformer.

[Claim 2]

The apparatus for direct decomposition of a hydrocarbon according to claim 1, wherein the recycling line is provided with a flow rate adjuster for adjusting a flow rate of the produced gas flowing through the recycling line.

[Claim 3]

The apparatus for direct decomposition of a hydrocarbon according to claim 2, further comprising a concentration ratio acquisition device that acquires a concentration ratio between the hydrocarbon having two or more carbon atoms and hydrogen in the raw material gas to which the produced gas has been supplied via the recycling line.

[Claim 4]

The apparatus for direct decomposition of a hydrocarbon according to any one of claims 1 to 3, wherein the first catalyst is a supported catalyst in which ruthenium or nickel is supported on alumina.

[Claim 5]

A method for direct decomposition of a hydrocarbon, which directly decomposes a hydrocarbon into carbon and hydrogen using a gas containing methane and a hydrocarbon having two or more carbon atoms as a raw material gas, the method comprising:

a methanation step of converting the hydrocarbon having two or more carbon atoms into methane;

a contact step of bringing a reformed gas obtained in the methanation step into contact with an iron-based catalyst; and

a recycle step of supplying a part of a produced gas obtained in the contact step to the raw material gas.

[Claim 6]

The method for direct decomposition of a hydrocarbon according to claim 5, wherein the recycle step comprises a step of adjusting a flow rate of the produced gas to be supplied to the raw material gas.

[Claim 7]

The method for direct decomposition of a hydrocarbon according to claim 6, wherein

the recycle step further comprises a step of acquiring a concentration ratio between the hydrocarbon having two or more carbon atoms and hydrogen in the raw material gas to which the produced gas has been supplied, and

the flow rate of the produced gas to be supplied to the raw material gas is adjusted based on the acquired concentration ratio.

[Claim 8]

The method for direct decomposition of a hydrocarbon according to claim 7, wherein the flow rate of the produced gas to be supplied to the raw material gas is adjusted so that the concentration ratio of hydrogen to the hydrocarbon having two or more carbon atoms is 1 or more.

[Claim 9]

The method for direct decomposition of a hydrocarbon according to claim 8, wherein the flow rate of the produced gas to be supplied to the raw material gas is adjusted so that the concentration ratio of hydrogen to the hydrocarbon having two or more carbon atoms increases.

[Claim 10]

The method for direct decomposition of a hydrocarbon according to any one of claims 5 to 9, wherein the methanation step is performed in a temperature range of from 250 to 500°C and a space velocity of from 930 to 10000 hr^{-1}.

[Claim 11]

The method for direct decomposition of a hydrocarbon according to any one of claims 5 to 10, wherein the raw material gas is natural gas, compressed natural gas, city gas, liquefied petroleum gas, or naphtha.