PATENT DOCUMENTS

[0007]

Patent Document 1: JP 04-180827 A

Patent Document 2: JP 2011-206648 A

Patent Document 3: JP 2015-98408 A

NON-PATENT DOCUMENT

[0008]

Non-Patent Document 1: https://www.toyo-eng.com/jp/ja/products/petrochmical/methanol/

SUMMARY

PROBLEM TO BE SOLVED BY THE DISCLOSURE

[0009]

In an ammonia decomposition reaction, a reaction in the reactor is also expected to be optimized by using a radial flow reactor as seen in Patent Documents 1 and 2 to achieve a lower pressure loss than that in a catalyst packed bed in an ordinary cylindrical reactor and the like and to control heat input. Furthermore, flowing from inside to outside to the contrary to a methanol synthesis reaction is expected to result in a decrease of the flow velocity as it passes through the reactor and a decrease of the dynamic pressure to advantageously perform a decomposition reaction in terms of equilibrium.

[0010]

However, when an ammonia decomposition reaction is performed using the reactor in Patent Documents 1 and 2, it is necessary to heat ammonia in an external furnace or heat exchanger before supplying it because the decomposition reaction of ammonia is an endothermic reaction. Nonetheless, there have been times when temperatures go uneven and efficiency is reduced depending on the flow of fluid in the reactor. Furthermore, even if the flow of fluid in the reactor can be controlled, a temperature difference between an upstream side and a downstream side of the reactor results in excessive heating in some places, leading to accelerating the deterioration of the catalyst, in an attempt to control a reaction temperature in the entire reactor. Although the reactor in Patent Document 3 can control upstream and downstream temperatures in the reactor to be different from each other, the pressure loss of catalyst layers is large and it is expected that arranging necessary wires and temperature sensors for each catalyst layer on a side of the reactor makes maintenance work including replacing them difficult. In particular, it has been considered difficult to boost the size

of a reactor.

[0011]

The purpose of the present disclosure is to provide a radial flow reactor with less uneven temperature even when an endothermic reaction is performed, small pressure loss, and easy maintainability as well, and also to provide a method for producing an ammonia decomposition mixture using the same.

MEANS OF SOLVING THE PROBLEM

[0012]

The present disclosure is a reactor, comprising:

a cylindrical reaction vessel disposed in an upright position, and

a reaction region inside of the reaction vessel, in which a chemical reaction is performed;

wherein the reaction region has a catalyst member, having a heating part generating heat by being energized and a catalyst disposed to be heated by the heating part, which is concentrically disposed in a cross-section perpendicular to an axial direction of the reaction vessel; and

wherein the reaction vessel comprises:

an outer flow channel which is formed on an outer side relative to the reaction region in a cross-section perpendicular to the axial direction of the reaction vessel and which is communicated with an outside of the reaction vessel,

a central flow channel which is formed on a center side relative to the reaction region in a cross-section perpendicular to the axial direction of the reaction vessel and which is communicated with an outside of the reaction vessel,

an outer flow channel wall separating the reaction region and the outer flow channel, through which fluid can pass, and

a central flow channel wall separating the reaction region and the central flow channel, through which fluid can pass.

[0012a]

In a first aspect, there is provided a reactor, comprising:

a cylindrical reaction vessel disposed in an upright position, and

a reaction region inside of the reaction vessel, in which a chemical reaction is performed;

wherein the reaction region has a catalyst member, having a heating part generating heat by being energized and a catalyst disposed to be heated by the heating part, which is concentrically disposed in a cross-section perpendicular to an axial direction of the reaction vessel;

wherein the reaction vessel comprises:

an outer flow channel which is formed on an outer side relative to the reaction region in a cross-section perpendicular to the axial direction of the reaction vessel and which is communicated with an outside of the reaction vessel,

a central flow channel which is formed on a center side relative to the reaction region in a cross-section perpendicular to the axial direction of the reaction vessel and which is communicated with an outside of the reaction vessel,

an outer flow channel wall separating the reaction region and the outer flow channel, through which fluid can pass, and

a central flow channel wall separating the reaction region and the central flow channel, through which fluid can pass; and

wherein the catalyst member is formed of a catalyst-supported wire, which has a wire-shaped electric heating wire as the heating part and a catalyst layer containing the catalyst and disposed on a surface of the electric heating wire.

[0013]

In another aspect, the present disclosure refers to a method for producing an ammonia decomposition mixture by a decomposition reaction of ammonia using the above-mentioned reactor, comprising:

introducing ammonia from the central flow channel into the reaction region,

energizing the heating part to heat the catalyst,

performing a decomposition reaction of ammonia in the reaction region to produce an ammonia decomposition mixture, and

discharging the ammonia decomposition mixture from the reaction region to the outer flow channel.

EFFECTS OF THE DISCLOSURE

[0014]

The present disclosure can provide a radial flow reactor with less uneven temperature even when an endothermic reaction is performed, small pressure loss, and easy maintainability as well, and can also provide a method for producing an ammonia decomposition mixture using the same.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

FIG. 1 is a schematic vertical cross-sectional view illustrating a configuration example of a reactor according to the present invention.

FIG. 2 is a schematic horizontal cross-sectional view illustrating a configuration example of a reactor according to the present invention.

FIG. 3 is a schematic view illustrating a surface structure of an outer flow channel wall or a central flow channel wall, where holes are formed on the surface in (a) and slits are formed on the surface in (b).

FIG. 4 is a schematic perspective view illustrating a configuration example of a catalyst-supported wire.

FIG. 5 is a schematic plan view illustrating a configuration example of a catalyst member using a catalyst-supported wire.

MODE FOR CARRYING OUT THE INVENTION

[0016]

FIG. 1 (vertical cross-sectional view) and FIG. 2 (horizontal cross-sectional view) illustrate a configuration example of a reactor according to the present invention. A reactor 1 according to the present invention is a so-called radial flow reactor, having a reaction vessel 2 which is disposed in an upright position and at least a center of which is cylindrical, and a reaction region 10 inside the reaction vessel 2, in which a chemical reaction is performed. Inside the reaction vessel 2, an outer flow channel 20 is formed on an outer side relative to the reaction region 10, and a central flow channel 30 is formed on a center side relative to the reaction region 10, in a cross-section perpendicular to an axial direction of the cylindrical reaction vessel 2.

[0017]

An outer flow channel wall 22 is disposed at a boundary between the reaction