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10 **Moulded insulation bodies**

Field of the invention

15 The invention relates to self-supporting moulded insulation bodies and to a process for the production thereof from a ceramic material comprising SiO_2 fibres and Al_2O_3 fibres. The invention further relates to the use thereof as insulating material in the cracking tube conduits of a tubular reactor for performing a steam reforming process.

20 **Prior art**

Self-supporting moulded insulation bodies made of a ceramic material comprising SiO_2 fibres and Al_2O_3 fibres are known. They are often employed in the cracking tube conduits of a tubular reactor for performing a steam reforming process.

25 Such steam reforming processes and the tubular reactors employed therein are used for conversion of gaseous hydrocarbons with steam into synthesis gas consisting mainly of carbon monoxide and hydrogen. They are known per se and described in principle, for example, in Ullmann's Encyclopedia of Industrial Chemistry, Sixth Ed., Vol. 15, chapter "Gas Production", chapt. 2.2. These tubular reactors consist essentially of a heating
30 space through which numerous so-called cracking tubes are vertically passed and heated. The cracking tubes are filled with a catalyst active for the reforming reactions in

the form of a fixed bed. The process gases, i.e. the reactant and product gases for the steam reforming process, are passed through the cracking tubes. The ends of the cracking tubes project from the heating space of the tubular reactor at the top and bottom for example and are often provided with an insulation to prevent heat losses and burns to operators.

Insulating materials employed are often SiO_2 - and Al_2O_3 -based fibre materials present as tapes or mats, and fitting and disassembly of the insulation is therefore complex and inconvenient. It would be more convenient to use dimensionally stable moulded insulation bodies that are easier to install and deinstall, have a sufficient service life and may optionally be reused. Such moulded insulation bodies shall especially also be employed in an insulation inside the cracking tube, i.e. as internal insulation, to protect the inner surface of the plant parts from temperatures which promote so-called metal dusting corrosion.

The use of the binder plays an important role in connection with a sufficient service life. It has been found in practice that when using an SiO_2 -containing and/or an organic binder the thus manufactured insulation bodies achieve only inadequate service lives under the process conditions of steam reforming. Due to the high process temperatures to which the insulation is subjected and the high steam content in the process gas these hitherto used binders are expelled from the ceramic material causing it to lose its stability and disintegrate.

The patent specification US 8,986,598 B2 describes a process for producing a moulded body from a refractory spinel-SiC composite material. This process uses an Al_2O_3 sol as a binder. The components involved are atypical insulation media for steam reforming.

The patent publication DE 602 22 841 T2 describes the production of a shaped ceramic matrix composite part wherein the matrix consists of a colloidal suspension of a metal oxide, for example aluminium oxide, into which aluminium oxide particles are blended.

Volatile components are then removed by applying a vacuum and kilning at temperatures between 815°C and 1260°C.

Neither publication addresses the use of proven fibre materials based on SiO₂ and Al₂O₃ and the use thereof for producing self-supporting longterm-stable moulded insulation bodies for use in steam reforming plants.

The problem addressed by the invention was therefore that of providing an insulation material/moulded insulation bodies for the steam reforming process which achieve a longer service life and comprise commonly used constituents.

Description of the invention

The object was achieved by a process for producing self-supporting moulded insulation bodies from a ceramic material comprising SiO₂ fibres and Al₂O₃ fibres according to Claim 1, by the moulded insulation bodies obtained according to Claim 2, and by the use thereof as insulation material in cracking tubes of a tubular reactor for performing a steam reforming process for generating synthesis gas according to Claim 4 and by a process according to Claim 7 for fitting a cracking tube with at least one moulded insulation body.

The motivation for using an Al₂O₃ sol as a binder for the production of self-supporting moulded insulation bodies from a ceramic material comprising SiO₂ fibres and Al₂O₃ fibres was taken from the abovementioned patent specifications US 8,986,598 B2 und DE 602 22 841 T2. The service life of the mouldings used for the internal insulation of the cracking tubes was improved through use of this binder.

The production of the moulded insulation bodies may be made more effective by performing process steps under vacuum conditions.

Preferred embodiments of the invention

A preferred embodiment of the invention is characterized in that the moulded insulation bodies are provided with a circular arc profile, preferably in the shape of a half shell or quarter shell, or are cylindrical. This enables/facilitates introduction and placement of the bodies at the locations in the cracking tubes intended for insulation.

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A further preferred embodiment of the use of the moulded insulation bodies is characterized in that the inlet for the reactants and the outlet for the products are arranged at opposite ends of the cracking tube which project out of the heating space of the tubular reactor, wherein the inlet region and/or the outlet region of the cracking tube are fitted with internal moulded insulation bodies having a circular arc profile. This embodiment has the advantage that the ends of the cracking tubes are readily accessible as a result of projecting from the heating space. However, to protect maintenance personnel against burns and to avoid unnecessary heat losses, a particularly good insulation of these tube ends is also required and is ensured by use of the moulded insulation bodies.

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A further preferred embodiment of the use of the moulded insulation bodies is characterized in that the inlet for the reactants and the outlet for the products are arranged at the same end of the cracking tube which projects out of the heating space of the tubular reactor and in that at the opposite end of the cracking tube a free interior space is present which serves to deflect the gas flow leaving the catalyst bed into a heat exchanger tube arranged inside the catalyst bed, wherein the Inlet region and/or the outlet region of the cracking tube are fitted with internal moulded insulation bodies having a circular arc profile and the free interior space is fitted with an internal moulded insulation body which is cylindrical. This embodiment too has the advantage that the ends of the cracking tubes are readily accessible as a result of projecting from the heating space. Said ends must likewise be well insulated for protection of maintenance personnel against burns and for avoidance of unnecessary heat losses and this can be ensured by use of the moulded insulation bodies.

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30 **Working examples**

Further features, advantages and possible applications of the invention are apparent from the following description of working and numerical examples and from the drawings. All described and/or depicted features on their own or in any desired combination form the subject matter of the invention, irrespective of the way in which they are
5 combined in the claims the way in which said claims refer back to one another.

The invention shall be more particularly elucidated with reference to the drawing.

Fig. 1 shows a cross section of the upper end of a cracking tube which passes
10 through the ceiling of the heating space of a tubular reactor,

Fig. 2 shows a cross section of the lower end of a cracking tube which passes through the floor of the heating space of a tubular reactor,

Fig. 3 shows a cross section of a cracking tube having an internal heat exchanger.
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In Fig. 1 the upper end 1 of a cracking tube 2 projects through the ceiling 3 of the heating space 4. The cracking tube 2 is not firmly connected to the ceiling 3 in order that the thermal expansion of the cracking tube 2 may be compensated by it growing out of the ceiling 3. A thin-walled, flexible tube 5 connects the upper end 1 of the cracking tube 2
20 with a distributor tube (not shown) from which the reactant gas is introduced into the cracking tube 2. The reactant gas is conducted through the catalyst fixed bed 6 through the cracking tube 2 to its lower end (not shown). The upper end 1 of the cracking tube 2 is provided with the internal moulded insulation body 7 consisting of the ceramic material according to the invention.
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Fig. 2 depicts by way of example how the lower end 8 of a cracking tube 2 is passed through the floor 9 of a heating space 4. The product gas emerges from the catalyst bed 6 and is introduced into the collection conduit 10. The collection conduit 10 is provided with an internal insulation 11. The lower end 8 of the cracking tube 2 is provided with the
30 internal moulded insulation body 7 consisting of the ceramic material according to the invention.

Fig. 3 shows how a cracking tube 2 having an internal heat exchanger 12 projects with its upper end 1 from the ceiling 3 of the heating space 4 and with its lower end 8 from the floor 9 of the heating space 4. The feed for the reactant gas 13 through which the
5 gas is introduced into the cracking tube 2 is also shown. The gas then ascends through the catalyst fixed bed 6 in the cracking tube 2 into the turnaround space 14 and flows from there through the heat exchanger tubes 12 into the collection conduit 10 for the product gas. The upper end 1 and the lower end 8 of the cracking tube 2 are provided with the internal moulded insulation body 7 consisting of the ceramic material according
10 to the invention.

Industrial applicability

The invention makes it possible to achieve higher service lives of the cracking tubes and accordingly improved economy of the steam reforming process. The invention is there-
15 fore advantageously economically employable.

List of reference numerals

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| | 1 | upper end of a cracking tube |
| | 2 | cracking tube |
| 5 | 3 | ceiling of a heating space of a tubular reactor |
| | 4 | heating space of a tubular reactor |
| | 5 | flexible tube |
| | 6 | catalyst fixed bed |
| | 7 | moulded insulation body |
| 10 | 8 | lower end of a cracking tube |
| | 9 | floor of a heating space of a tubular reactor |
| | 10 | collection conduit for product gas |
| | 11 | collection conduit insulation |
| | 12 | heat exchanger tubes |
| 15 | 13 | feed for reactant gas |
| | 14 | turnaround space for gas flow inside the cracking tube |

Claims:

1. Use of a self-supporting moulded insulation body as insulation material in cracking tubes of a tubular reactor for performing a steam reforming process for generating synthesis gas, wherein the self-supporting moulded insulation body is made from a ceramic material comprising SiO_2 fibres and Al_2O_3 fibres, and is obtained comprising the following steps:

(a) providing a flowable mixture comprising SiO_2 fibres and Al_2O_3 fibres and also an Al_2O_3 sol as a binder,

(b) producing a preform by filling, in particular pouring or pressing, the mixture obtained in (a) into a hollow mould having a circular arc shape,

(c) kilning the preform obtained in step (b) at a temperature of at least 800 °C.

2. Use of a self-supporting moulded insulation body according to Claim 1, wherein the shape is preferably in a half shell or quarter shell, or is cylindrical.

3. Use of a self-supporting moulded insulation body according to Claim 1 or 2, characterized in that in the cracking tube of a tubular reactor, the inlet for the reactants and the outlet for the products are arranged at opposite ends of the cracking tube which project out of the heating space of the tubular reactor, wherein the inlet region and/or the outlet region of the cracking tube are fitted with internal moulded insulation bodies having a circular arc profile.

4. Use of a self-supporting moulded insulation body according to Claim 1 or 2, characterized in that in the cracking tube of a tubular reactor, the inlet for the reactants and the outlet for the products are arranged at the same end of the cracking tube which projects out of the heating space of the tubular reactor and in that at the opposite end of the cracking tube a free interior space is present which serves to deflect the product gas flow leaving the catalyst bed in the cracking tube into a heat exchanger tube arranged inside the catalyst bed, wherein the inlet region and/or the outlet region of the cracking tube are fitted with internal moulded insulation bodies having a circular arc profile and the free interior space is fitted with an internal moulded insulation body which is cylindrical.

5. Process for fitting a cracking tube of a tubular reactor for performing a steam reforming process for generating synthesis gas with at least one moulded insulation body according to Claim 1 or 2, characterized in that the moulded insulation bodies are introduced into the region of the cracking tube to be insulated.