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Methane pyrolysis test plant at the Ludwigshafen site

Footage material

BASF has commenced operations in a test plant for methane pyrolysis at the Ludwigshafen Verbund site. The test plant was completed at the end of 2020 and is a decisive step toward large-scale implementation which should be possible before 2030.

Simply advancing development in the existing system will not be sufficient to significantly reduce the greenhouse gas emissions further when producing chemical products – in fact, this will require completely new technologies. To produce hydrogen from natural gas or biomethane in a climate-friendly manner, BASF is collaborating with cooperation partners in a project funded by the German Federal Ministry of Education and Research (BMBF; funding code 03SF0571A) to develop methane pyrolysis technology as part of the Carbon Management Research and Development Program. This approach splits natural gas or biomethane directly into hydrogen and solid carbon. The methane pyrolysis process requires around 80% less electricity than alternative hydrogen production methods using water electrolysis and if electricity from renewable sources is used, the process itself would generate almost zero CO2.

(01) Methane pyrolysis – Climate-friendly hydrogen for chemistry

(09-24-2021 / 5‘03 / MIX / Report)

By the year 2030, we want to reduce our emissions by 25% compared to 2018 and are committed to achieving net-zero emissions by 2050. This will not be possible without

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innovative chemistry. Hydrogen is an important and key element that will be essential in helping make chemistry climate-neutral.

BASF relies on different technologies to produce hydrogen, with the technology selected depending on the situation, site and availability of renewable electricity. This also includes methane pyrolysis. The project is funded by the German Federal Ministry of Education and Research (BMBF) (funding code 03SF0571A).

TRANSCRIPT

Dr. Detlef Kratz *(subtitled)*
Head of Process Research & Chemical Engineering

00:07 – 00:25 We want to reduce our greenhouse gases by 25% by 2030 compared to 2018 and to zero by 2050. This will not be possible without innovative chemistry. Hydrogen as an important central element will make a very essential contribution to making chemistry climate-neutral.

Dieter Flick *(subtitled)*
Project Manager Methane Pyrolysis

00:27 – 00:43 Hydrogen is an invisible, non-toxic gas. And there is an enormous amount of potential in this gas. No chemical company manufactures more products from hydrogen than BASF. We need hydrogen, for example, to produce ammonia, plastics, fibers or vitamins.

Comment

00:45 – 01:14 Unfortunately, there are no significant natural sources of hydrogen. Today hydrogen is mainly produced from natural gas using classical steam reforming. This process leads to high CO2 emissions. This makes the production of hydrogen one of the largest CO2 emitters in chemical production. Clean hydrogen is therefore a key to the success of the transformation to climate friendly chemistry. This is what we are tackling at BASF.

Dr. Detlef Kratz *(subtitled)*
Head of Process Research & Chemical Engineering

01:16 – 01:30 We definitely need innovative technologies. It won't be enough just to rely on electrolysis. It will also be a matter of being energy efficient. That's why we're looking for energy-efficient processes, such as methane pyrolysis, to take that forward.

Comment

01:32 – 01.48 BASF relies on different technologies to produce hydrogen. These can be used depending on the situation, location and availability of renewable electricity. In addition to water electrolysis. This also includes methane pyrolysis.

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Dieter Flick *(subtitled)*
Project Manager Methane Pyrolysis

01:50 – 02:09 In methane pyrolysis, methane from natural gas or biomethane is split into its components: hydrogen and carbon. This requires temperatures of up to 1400 degree Celsius. At BASF, we have been working on methane pyrolysis since 2010. This project is funded by the German Federal Ministry of Education and Research.

Dr. Frederik Scheiff *(subtitled)*
Team Leader High Temperature Reactions

02:11 – 02:43 Last year, we built the plant for methane pyrolysis here and have now successfully commissioned it. That was a super moment for us as a team and also an important milestone on the way to climate-friendly hydrogen. Now, however, there are two challenges to master: Frist. Mastering the process technology – with electrical heating ant the use of innovative materials in this reactor. And the right process control. That means determining the right operating window for this reactor.
After the first few weeks of trial operations here, we are confident and can look forward to further trial operation with great optimism.

Comment

02:44 – 03:16 The Ludwigshafen methane pyrolysis plant is the only one to use a moving bed of carbon. Millimeter sized carbon is fed into the top of the test reactor. This bulk produces what is known as the carbon bed. This slowly migrates downward due to gravity, hence the name moving bed. The methane flows through the bed from the bottom to the top and decomposes. The resulting carbon is deposited on the bed and is conveyed out of the reactor at the bottom.

Daniela Rieck *(subtitled)*
Teamlead overall process

03:19 – 03:39 The advantage of methane pyrolysis is that we have no direct CO2 emission from the process. And the second advantage is that we need much less energy compared to electrolysis – about one fifth. But of course, it is very important that we then also use renewable energy.

Dieter Flick *(subtitled)*
Project Manager Methane Pyrolysis

03:41 – 04:09 Our team is working flat out to find the top conditions for operating the plant. This involves varying temperature, pressure and volume settings to optimize the process and close the loops. Fine-tuning and detailed work are enormously important to make such a project a breakthrough. The good thing is that single person in the team is 100% committed. That's why we've succeeded in taking the idea out of the lab and into trial operation. We are all extremely proud of that.

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Comment

04:10 – 04:25 Once the test plant is running stably and sufficient quantities of the carbon are available a second phase of the project will examine which applications for the resulting pyrolysis carbon are technically feasible and useful.

Dr. Detlef Kratz *(subtitled)*
Head of Process Research & Chemical Engineering

04:27 – 04:43 We are firmly convinced the methane pyrolysis represents a contribution to both, sustainability contribution and profitability for BASF. And we will have something fundamental to counteract climate change – with a CO2 neutral process like methane pyrolysis. And we are working on that now and will scale that up.

Comment

04:45 – 05:02 Methane pyrolysis is an important element for BASF to reduce greenhouse gas emissions. This applies to the Ludwigshafen site and worldwide.

(02) Methane pyrolysis test facility – Activities in the facility

(09-24-2021 / 4‘47 / ATMO / Footage)

The successful production of hydrogen and high-purity carbon in the test plant and the subsequent commercial implementation of the process in a pilot plant would represent a breakthrough not only for the research team at BASF. The new production process could also be an important element of a process to reduce CO2 in the production of basic chemicals, such as ammonia and methanol, throughout the entire chemical industry.

For projects like these, there is a very long journey from the initial idea to the realization of said idea, and the expertise of the entire project team is required for the construction and operation of the test plant.

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(03) Methane pyrolysis test facility – Inspection tour

(09-24-2021 / 6‘28 / ATMO / Footage)

Hydrogen is one of the most important raw materials in the chemical industry, with almost every end product requiring hydrogen at some point in the manufacturing process.

Currently, around 9-10 metric tons of CO2 are generated for every metric ton of hydrogen produced. As such, producing hydrogen using a more environmentally friendly method is a significant milestone in climate protection and there is great interest in the methane pyrolysis approach.

(04) Methane pyrolysis test facility – Aerial shots (day and night)

(09-24-2021 / 6‘21 / ATMO / Footage)

BASF is one of the largest producers of hydrogen in Europe. Each year, we use around 250,000 metric tons of hydrogen at our Ludwigshafen site alone, with the element produced either in the steam reformer, or generated as tying or by-products from production.

Hydrogen is a core and irreplaceable reactant for important products such as ammonia and is also found in many consumer products, from chewing gum to plastics.

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