Industrial Solutions

uhde® entrained-flow gasification

End-to-end solutions for all feedstocks and applications

thyssenkrupp

One-stop shop for technology, EPC and service

With nearly 100 years of experience in chemical engineering and global project execution, we are a reliable life-cycle partner for our customers. From first idea to turnkey project as well as after-sales services to enhance lifetime and performance – you can count on us to help you get the most out of your assets.

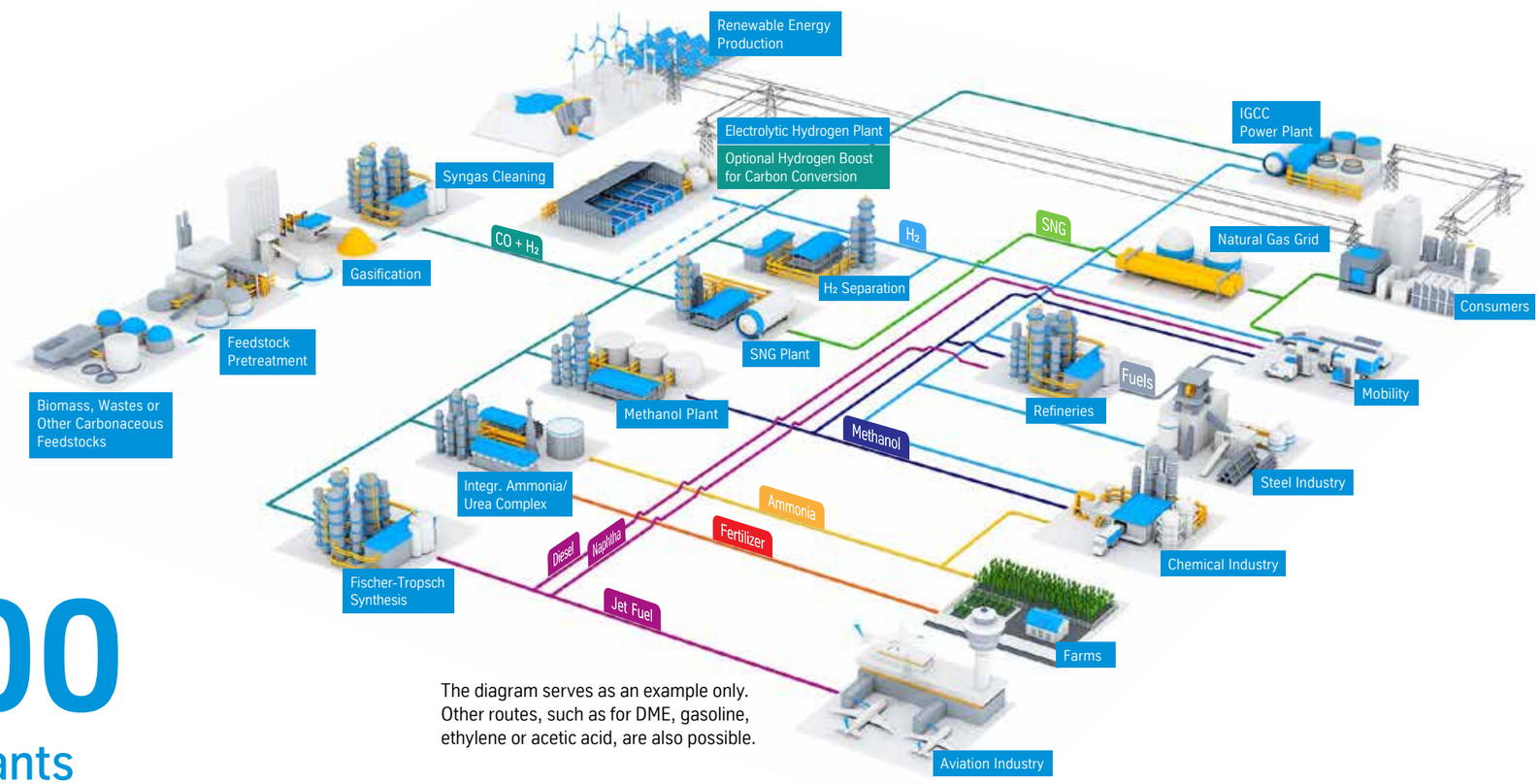
More than

2,500

chemical plants built worldwide

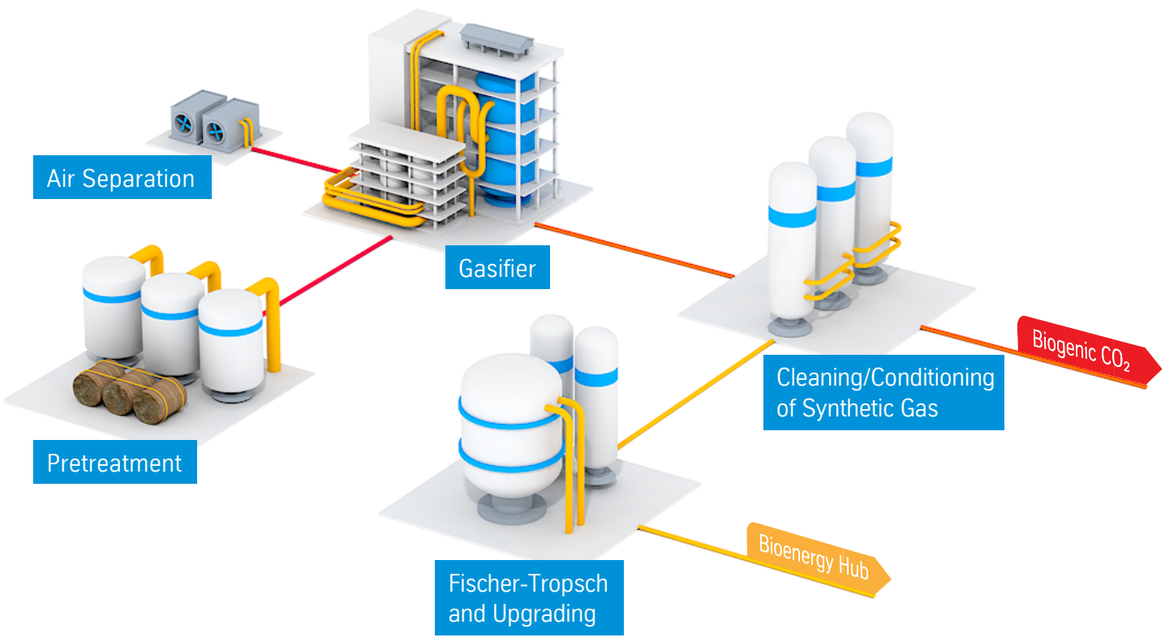
Decarbonization and climate protection: Green syngas and chemicals

With our unique portfolio ranging from large-scale solids gasification and water electrolysis to downstream applications, we can enable carbon-reduced or even completely CO_2-free value chains. All from a single source.



The diagram serves as an example only. Other routes, such as for DME, gasoline, ethylene or acetic acid, are also possible.

Advanced biofuels



A significant step towards decarbonization and increased energy independence

The BioTfueL® project launched by Avril, Axens, CEA, IFPEN, thyssenkrupp Industrial Solutions and Total aims to achieve the conversion of lignocellulosic biomass (straw, forest waste, dedicated energy crops) into high-quality advanced biofuels, such as renewable diesel, SAF (sustainable aviation fuel) and naphtha, via an indirect thermochemical pathway while at the same time ensuring minimum environmental impact. The tests performed in the large-scale demonstration plants under representative conditions have exceeded expectations.

Applying the uhde® entrained-flow gasification process with direct quench (PDQ), various types of fossil feedstocks can be co-processed, allowing possible seasonal variations in biomass availability to be bridged and the commercial viability of the process to be maximized.

The advanced biofuels produced, which are free of sulfur, olefins, oxygenates and aromatics, can either be used as drop-in fuels without the need to modify current infrastructure and vehicles or as blend in all types of diesel or turbojet engines without requiring engine retrofits.

The BioTfueL® concept is consistent with the objectives set out in the European RED II directive, which stipulates that advanced biofuels should provide 3.5% of transport energy by 2030.

Facts and figures

- All of the BioTfueL® core technologies have long proven themselves commercially successful, and include entrained-flow gasification and Fischer-Tropsch technologies.
- The BioTfueL® partners include two technology providers who bring extensive experience from their respective backgrounds: thyssenkrupp, who have designed, built and successfully commissioned over 100 gasifiers; and Axens, who have licensed the use of their proprietary Fischer-Tropsch synthesis & upgrading technology (Gasel®) in over 3,000 industrial units in the oil refining, petrochemicals, natural gas, alternatives & renewables and water treatment sectors.
- BioTfueL® is set to play a key role in the decarbonization of the transport sector with advanced fuels and products.
- It is envisaged that commercial-scale BioTfueL® plants will have a capacity of up to 5,000 barrels/day of advanced biofuels.
- The successful operation runs of the demonstration plants in Venette and Dunkirk have supplied valuable data for the design of a variety of feedstocks and plant capacities.

A clean and efficient pathway from feedstock to product

Environmental protection is becoming increasingly important. Based on our uhde® gasification process we can design and implement optimized process chain solutions from a single source.

High-value products and by-products
The main product of gasification processes based on our uhde® entrained-flow gasification (also known as PRENFLO) technology is syngas. Thanks to our unique portfolio, which is complemented by various downstream processes, we can offer you complete end-to-end solutions.

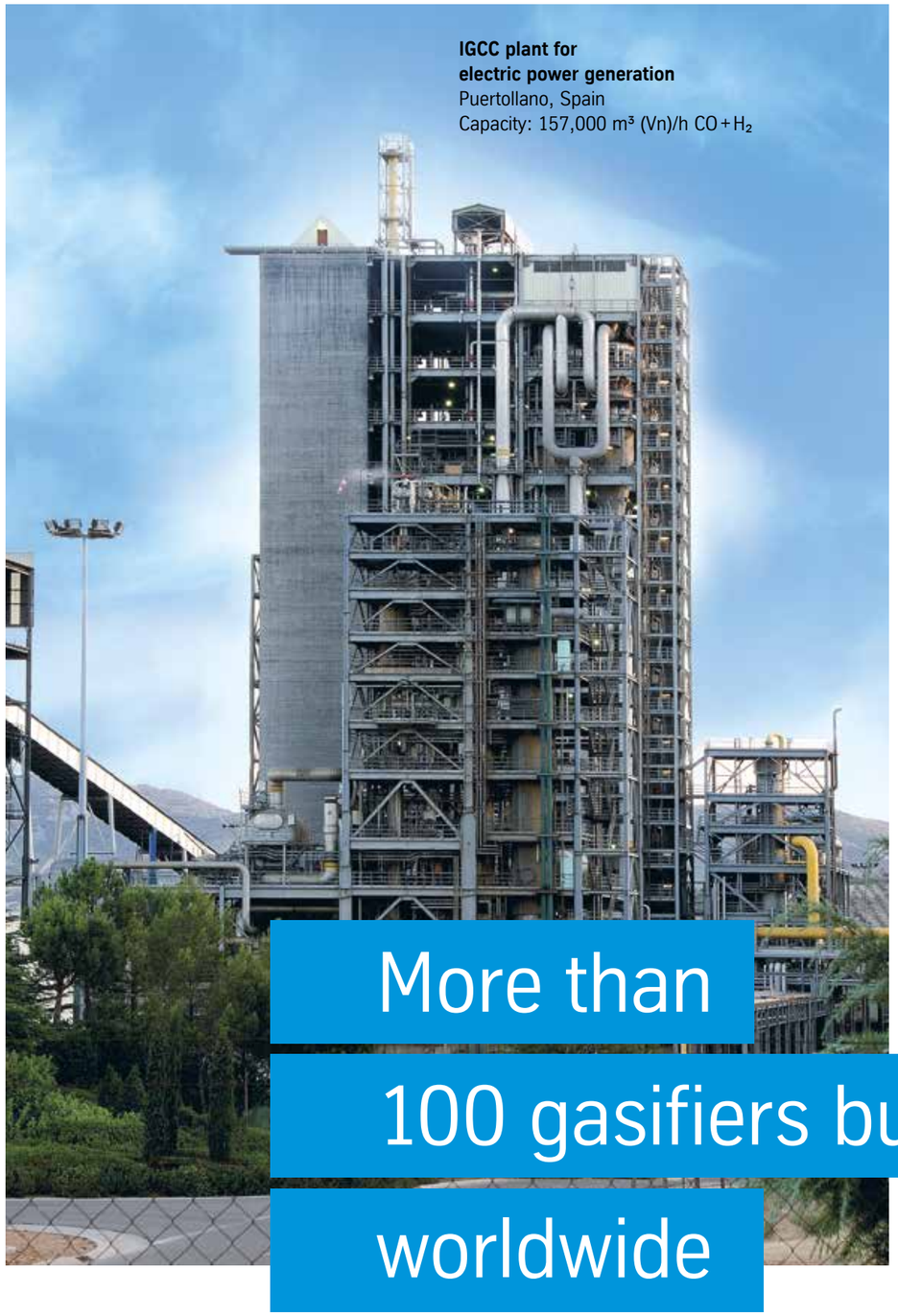
Alongside the main products, the by-products of our gasification are also valuable. The slag can be used in road-building, fly ash is used in the cement industry, and sulfur or sulfuric acid can be readily recovered and marketed.

Multifuel capability
This special feature allows the co-feeding of liquid and gaseous feedstocks.

uhde® entrained-flow gasification

- Reduced operating costs
- Use of low-value feedstock or waste
- Higher-value products, e.g. methanol, ammonia, urea, DME, SNG, jet fuel, gasoline/LPG, diesel/naphtha, hydrogen, waxes
- Environment-friendly solutions
- High electrical efficiency in power generation
- Multifuel capability
- A basis for carbon capture and storage / utilization (CCS / CCU)

One technology, maximized feedstock flexibility



IGCC plant for electric power generation
Puertollano, Spain
Capacity: 157,000 m³ (Vn)/h $CO + H_2$

With decades of experience in the design and implementation of gasification plants based on eight different technologies, and more than 100 gasifiers built, we can proudly say that our current uhde® entrained-flow gasification process is the result of continuous research, development and optimization.

Gasification plant for the production of ammonia and methanol
Modderfontein, South Africa
Capacity: 90,000 m³ (Vn)/h $CO + H_2$

Demonstration plant
Fürstenhausen, Germany
Capacity: up to 3,300 m³ (Vn)/h $CO + H_2$

Demonstration plant for the production of advanced biofuels
Dunkirk, France
Capacity: up to 3,100 m³ (Vn)/h $CO + H_2$

uhde® entrained-flow gasification with steam generation (PSG)

The uhde® entrained-flow gasification process with steam generation, which operates at elevated pressure, can be used to gasify all types of solid feedstocks (coal, petroleum coke and biomass). It is a further development of the Koppers-Totzek process developed in the 1940s, which operates at atmospheric pressure and was specially designed for power generation applications.

The lessons learnt from more than two decades of experience in operating the uhde® PSG entrained-flow gasification process have consistently formed the basis for subsequent successful applications.

Flow diagram of the uhde® entrained-flow gasification process (PSG)

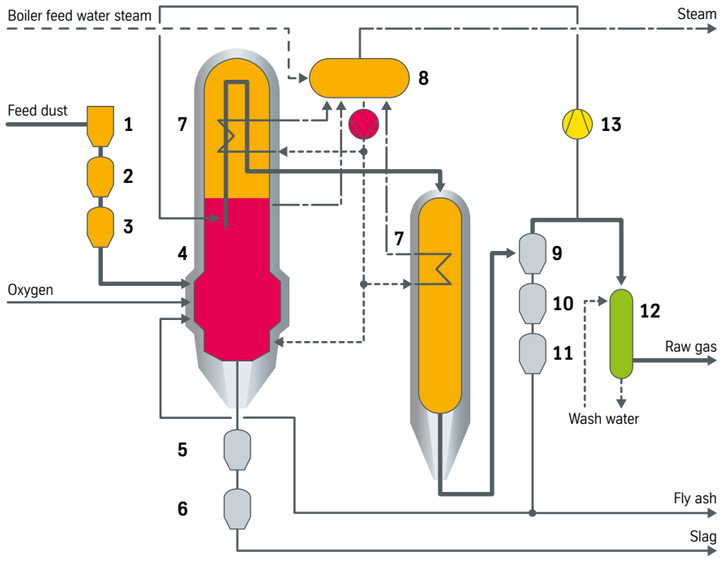
Main process data:

Gasification pressure:
40 bar and higher

Gas temperature at outlet of gasifier waste heat boiler:
250-300°C

Carbon conversion:
> 99 %

Typical raw gas composition:
$CO + H_2$ > 85 vol. %
CO_2 2-4 vol. %
CH_4 < 0.1 vol. %



1 Cyclone filter
2 Lock hopper
3 Feed bin
4 PSG gasifier
5 Slag crusher/collector (if required)
6 Slag lock hopper
7 Waste heat boiler
8 Steam drum
9 Filter
10 Fly ash lock hopper
11 Fly ash feed bin
12 Scrubber
13 Quench gas compressor

Process description

First, the feed dust is prepared in the feed preparation unit. Approximately 80% of the dust must be smaller than 0.1 mm. This feed dust is then gasified in the uhde® entrained-flow gasifier using oxygen and steam as gasification agents. The gasification temperature is higher than the ash melting temperature, which allows the feedstock ash to be removed as slag. The cooled-type gasifier is equipped with multiple, horizontally arranged burners.

In the uhde® entrained-flow process with steam generation (PSG), the raw gas produced, which contains mainly carbon monoxide and hydrogen, is cooled in the waste heat boiler, generating steam. The gas is then dedusted in a candle filter and further treated in a Venturi scrubber.

The slag from the gasifier can be used as a construction material and the fly ash from the candle filter as a feedstock in the cement industry.

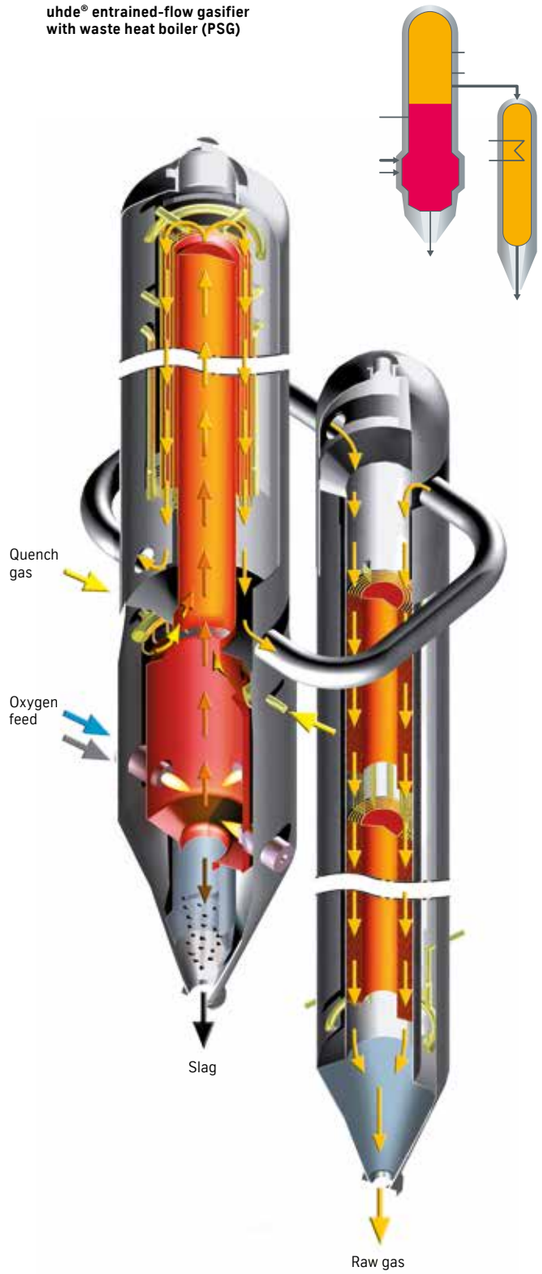
The uhde® entrained-flow gasification process with steam generation was used at the world's largest single-train, dry-fed, solid-feedstock-based IGCC power plant in Puertollano, Spain. For more than 17 years this plant operated with a mixture of petroleum coke and high-ash/low-rank coal as well as the occasional biomass co-feed.

Single-train capacity up to 1,200 MWth

Main features of the PSG process:

- Entrained flow
- Dry dust feed for high efficiency
- Multiple burners with high availability and long lifetime
- Horizontally arranged burners for high carbon conversion
- Membrane wall with long lifetime
- Waste heat boiler for efficient heat recovery
- Operates above ash melting point

uhde® entrained-flow gasifier with waste heat boiler (PSG)



uhde® entrained-flow gasification with direct quench (PDQ)

The uhde® entrained-flow gasification process with direct quench (PDQ) is an optimized design of the proven PSG gasification process for chemical applications (e.g. ammonia, methanol, hydrogen, synthetic fuel) and IGCC plants with carbon capture and storage (CCS), where hydrogen-rich syngases are required. Here, the technologically advanced dry feed system, multiple burners and membrane wall of the uhde® entrained-flow gasification process with steam generation (PSG) are combined with a proprietary water quench system which saturates the raw syngas with water for subsequent gas treatment.

Capital-intensive systems, such as the waste heat boiler system, the dry fly ash removal system and the quench gas compressor, are therefore no longer required.

Flow diagram of the uhde® entrained-flow gasification process (PDQ)

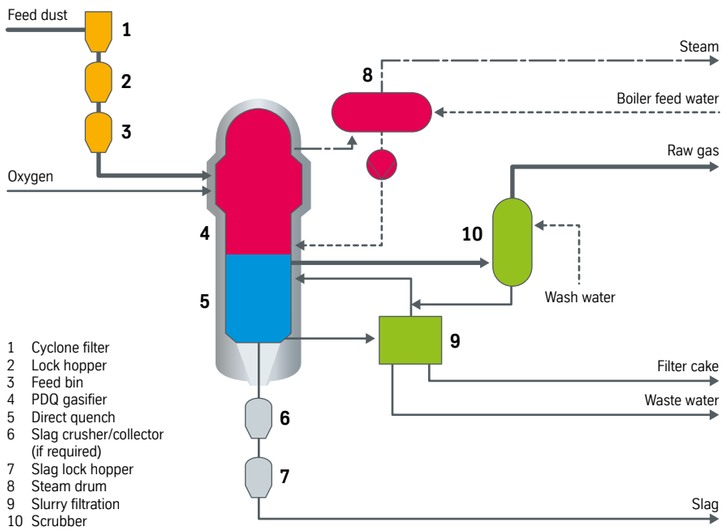
Main process data:

Gasification pressure:
40 bar and higher

Gas temperature at outlet of gasifier quench:
200 - 250 °C

Carbon conversion:
> 99 %

Typical raw gas composition:
$CO + H_2$ > 81 vol. %
CO_2 6 - 8 vol. %
CH_4 < 0.1 vol. %



Process description

First, the feed dust is prepared in the feed preparation unit. Approximately 80% of the dust must be smaller than 0.1 mm. This feed dust is then gasified in the uhde® entrained-flow gasifier using oxygen and steam as the gasification agent. The gasification temperature is higher than the ash melting temperature, which allows the feedstock ash to be removed as slag. The cooled-type gasifier is equipped with multiple, horizontally arranged burners.

The raw gas produced, which contains mainly carbon monoxide and hydrogen, is quenched with water in the gasifier direct quench and then cleaned in a scrubber.

The filter cake from the slurry filtration system is mainly recycled to the gasifier via the feed preparation unit.

The slag from the gasifier can be used as a construction material.

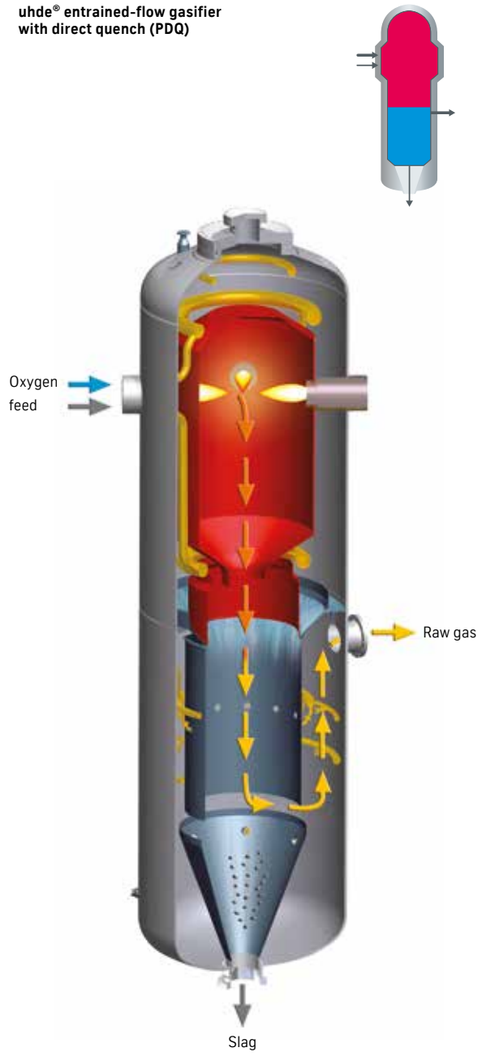
The uhde® entrained-flow gasification process with direct quench is used in Bionext's BioTfueL® plant for advanced biofuels in Dunkirk, France.

Single-train capacity up to 1,200 MWth

Main features of the PDQ process:

- Entrained flow
- Dry dust feed for high efficiency
- Multiple burners with high availability and long lifetime
- Horizontally arranged burners for high carbon conversion
- Membrane wall with long lifetime
- Full water quench for syngas saturation
- Shorter supply and construction schedule
- Lower investment cost
- Operates above ash melting point

uhde® entrained-flow gasifier with direct quench (PDQ)



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Chemical and Process Technologies

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