Future of Ammonia
Technology

الإتحاد العربي للأسمدة
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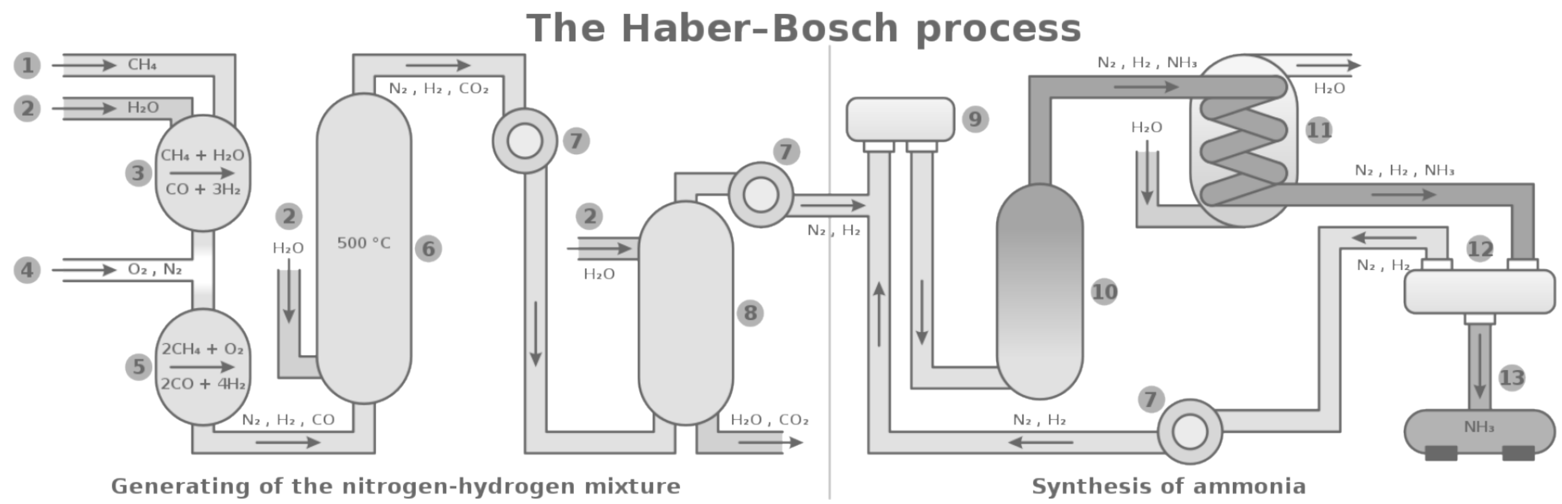
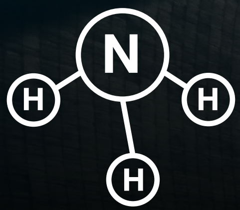
Technology

Ammonia technology has been in use for over a century, and it is an essential component of many industrial processes. The current state of ammonia technology can be described as follows:

1. **Haber-Bosch process:** The Haber-Bosch process is the most widely used technology for ammonia production. The process involves the reaction of nitrogen and hydrogen gases over a catalyst at high temperature and pressure. The process is energy-intensive and relies on natural gas as a feedstock.



2. **Steam methane reforming:** Steam methane reforming is a process used to produce hydrogen, which can then be used as a feedstock for ammonia production. The process involves the reaction of methane with steam over a catalyst at high temperature and pressure. It is a widely used technology but produces significant greenhouse gas emissions.



Ammonia production is associated with environmental concerns, including greenhouse gas emissions. Efforts are underway to reduce the environmental impact of ammonia production, including the development of carbon capture and utilization technologies and the use of renewable energy sources.

Research and Development Efforts

Research and development efforts are ongoing to improve the efficiency and sustainability of ammonia production. The future of ammonia production technology is likely to be characterized by increased efficiency, reduced environmental impact, and greater flexibility in feedstock selection. Possible trends that could shape the future of ammonia production are:

Renewable energy:

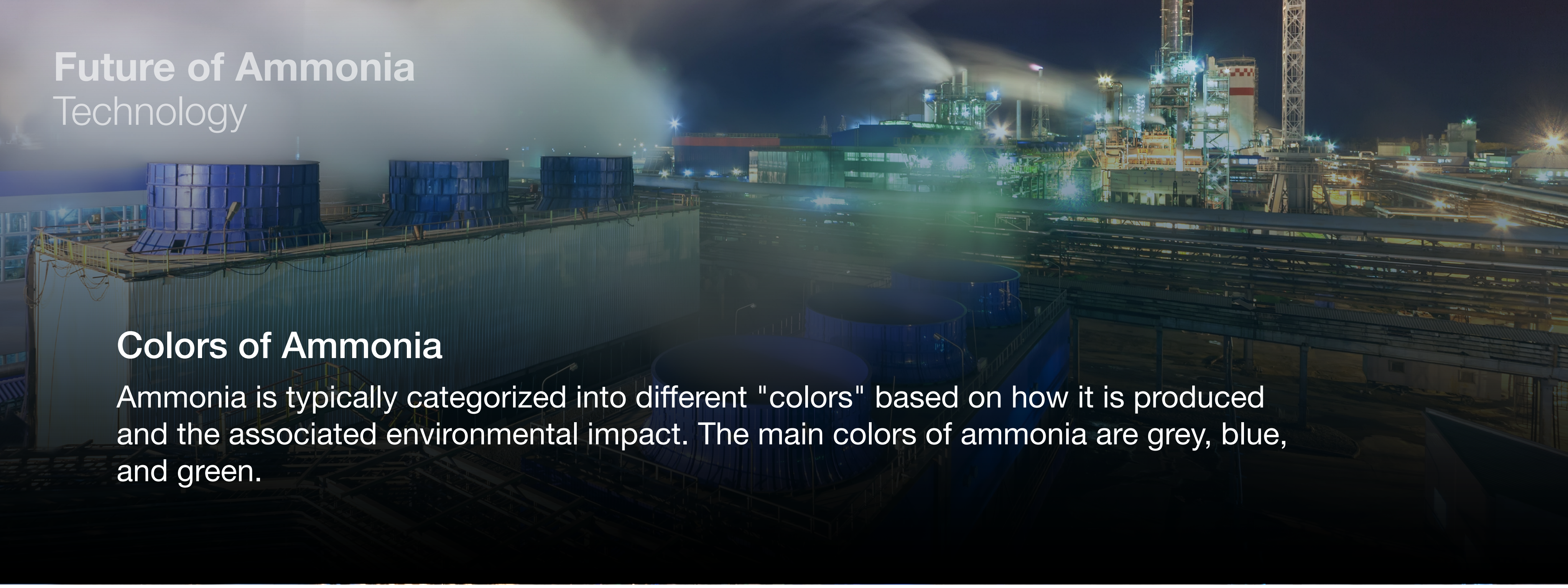
Ammonia is currently produced using natural gas as a feedstock. However, there is growing interest in using renewable energy sources, such as wind and solar, to power the ammonia synthesis process. This could lead to a significant reduction in greenhouse gas emissions associated with ammonia production.

Improved catalysts:

Catalysts are critical to the ammonia synthesis process, and research is ongoing to develop new and improved catalysts that could increase efficiency and reduce the amount of energy required to produce ammonia.

Carbon capture and utilization:

Carbon capture and utilization technologies could be used to capture carbon dioxide emissions from ammonia production and use them as a feedstock for other products, such as chemicals and fuels.



Colors of Ammonia

Ammonia is typically categorized into different "colors" based on how it is produced and the associated environmental impact. The main colors of ammonia are grey, blue, and green.

Grey ammonia

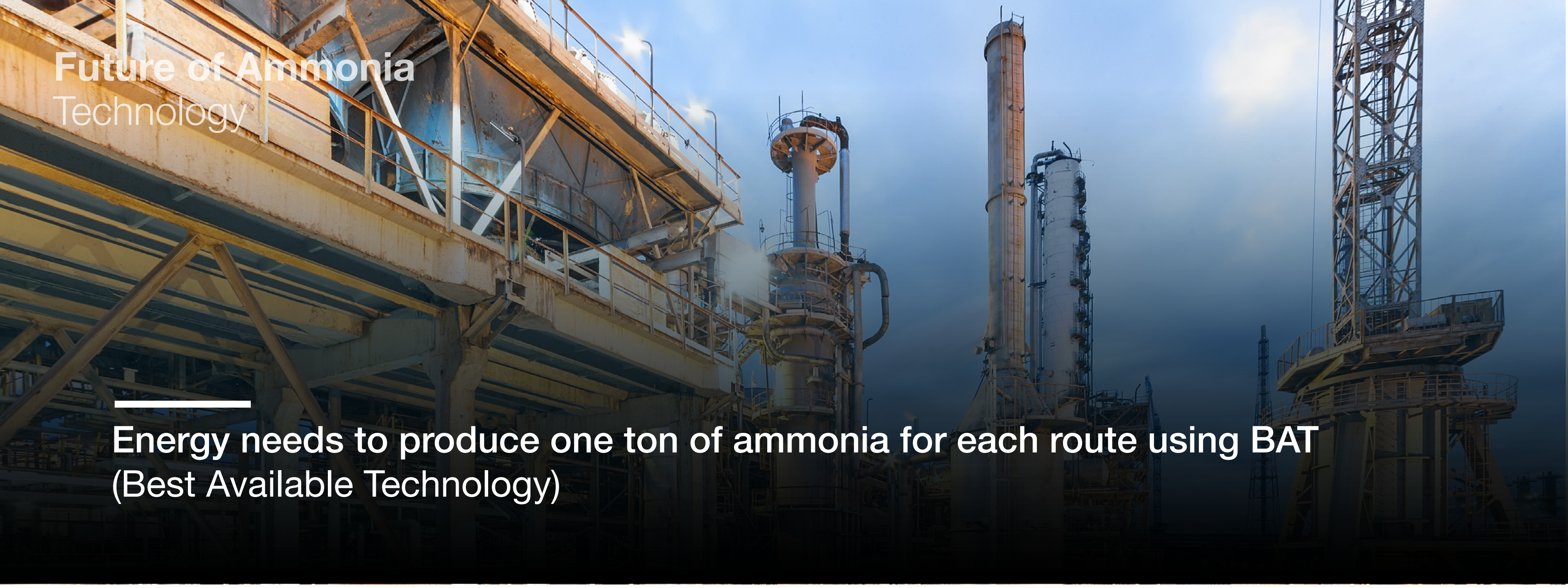
Refers to ammonia produced using conventional methods, such as the Haber-Bosch process, without any carbon capture or emission reduction measures. Grey ammonia is the most widely produced type of ammonia and has a high carbon footprint, with direct CO2 emissions of around ***2.2-1.8 tons per ton*** of ammonia produced.

Blue ammonia

Refers to ammonia produced using conventional methods but with carbon capture and storage (CCS) technologies to reduce its carbon footprint. Blue ammonia has a significantly lower carbon footprint than grey ammonia, with direct CO2 emissions reduced by around ***%95-90.***

Green ammonia

Refers to ammonia produced from renewable energy sources, such as wind or solar power, using electrolysis to produce hydrogen and nitrogen from water and air, respectively. Green ammonia has ***zero direct CO2*** emissions and is considered a sustainable and environmentally friendly option. However, it currently has a higher production cost compared to grey and blue ammonia due to the cost of renewable electricity and the electrolysis process.



Energy needs to produce one ton of ammonia for each route using BAT (Best Available Technology)

PRODUCTION ROUTE	NET ENERGY INTENSITY (GJ/T)	DIRECT CO2 INTENSITY (T CO2/T)
NATURAL GAS SMR	27.6	1.8
NATURAL GAS ATR	28.9	1.6
COAL GASIFICATION	36.1	3.2
SMR WITH CCS	30.0	0.1
ATR WITH CCS	29.4	0.1
COAL WITH CCS	41.2	0.2
ELECTROLYSIS	34.4	0.0
BIOMASS GASIFICATION	36.5	0.0
METHANE PYROLYSIS	47.5	0.0

Note: Energy intensity values include the feedstock and fuel required for each production route, as well as the electricity and steam needs. Direct CO2 intensity values only include emissions from the ammonia production process itself. Gross CO2 intensity values include emissions from the entire process, including the production of feedstocks and fuels. Net CO2 intensity values are calculated by subtracting any CO2 that is captured and stored during the production process.

Near-Zero-Emission Ammonia Plant

- A typical near-zero-emission ammonia plant would likely use one of two configurations: a SMR (steam methane reforming) plant with full CO2 capture retrofit to both the concentrated and dilute streams or a new-build ATR (autothermal reforming) plant with capture of its concentrated stream. The electrolysis-based plant would also be a near-zero-emission option but would be the most expensive of the three due to the high cost of electrolyser technology.
- The CAPEX (capital expenditure) for a typical SMR plant, including engineering, procurement, and construction costs, would be around USD 1,675 million for an 875 kt per year reference-scale plant. The fixed annual OPEX (operating expenditure), excluding energy costs, would be around %2.5 of the total initial capital outlay per year, or around USD 50 million per year. For the CCUS (carbon capture, utilization, and storage) retrofit configuration.

CAPEX of around USD 335 million would be required (excluding the cost of the existing plant), and annual fixed OPEX for the plant would rise by around %20. The ATR configuration is estimated to be just under %10 less expensive than the retrofit configuration when including the cost of the original SMR plant, so would be the likely choice for new-build plants.

The amount of natural gas consumed per year would be around 7,810 GWh for a typical new-build SMR plant, assuming BAT (best available technology) energy performance levels. For the CCUS-equipped configurations, natural gas consumption would be broadly similar, but with 5-3 times higher electricity needs due to the operation of the compressors and separation processes that make up the capture equipment. The electrolysis-based plant does not consume any natural gas but would require 120-20 times more electricity than the other configurations.

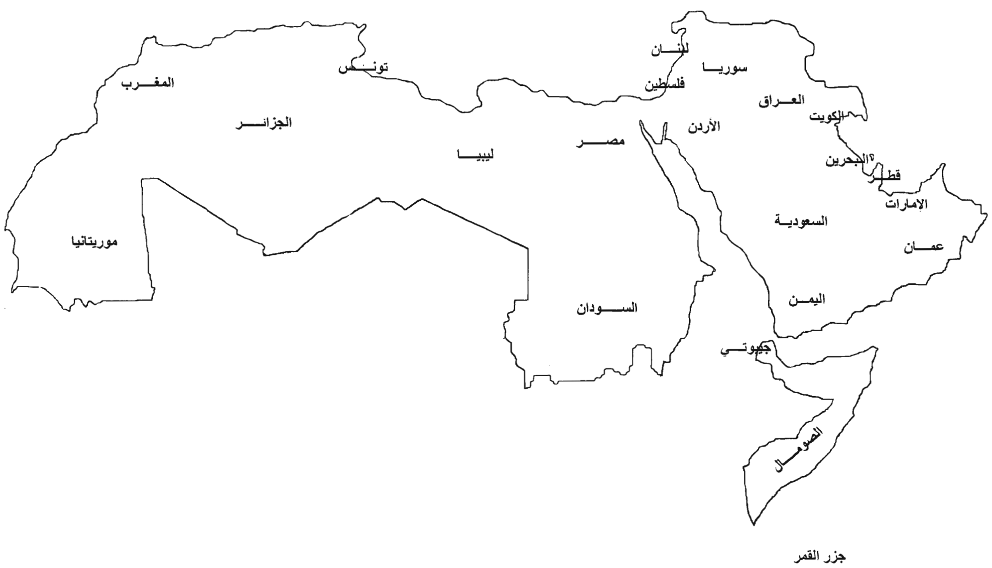
In terms of CO_2 emissions, an SMR plant of the reference-scale size would generate around 1,580 kt CO_2 per year if operated around the clock. The CCUS configurations would yield a reduction in direct CO_2 emissions of %95-90.

while the electrolysis-based plant would have zero direct CO_2 emissions. Indirect CO_2 emissions from electricity generation depend entirely on the technologies and fuels used in the power sector and should tend rapidly towards zero in the context of a sustainable future for the ammonia industry.

Blue Ammonia in Arab countries

- Arab countries have a strong competitive advantage in producing blue ammonia due to their abundant natural gas reserves, investments in CCS technologies, and well-established infrastructure and logistics networks. As demand for low-carbon ammonia grows globally, the Arab countries are well-positioned to become major producers and exporters of blue ammonia.

Due to their abundant natural gas reserves, the Arab countries have a significant advantage in producing blue ammonia. The production of blue ammonia requires large amounts of natural gas, which is a key feedstock for ammonia production. The Arab countries have some of the largest natural gas reserves in the world, which gives them a cost advantage over other regions.



In addition, the Arab countries have been investing heavily in carbon capture and storage (CCS) technologies, which are essential to produce blue ammonia. The implementation of CCS technologies enables the capture and storage of CO2 emissions during the ammonia production process, reducing the carbon footprint of the final product. The Arab countries have been investing in CCS technologies to comply with their commitments to reduce greenhouse gas emissions under the Paris Agreement and to diversify their economies away from fossil fuels.

Due to proximity to key markets in Asia and Europe, the Arab countries have well-established infrastructure and logistics networks for the export of ammonia to key markets. The strategic location of the Arab countries allows for easy access to Asian and European markets, which are the main importers of ammonia. This provides the Arab countries with a competitive advantage in terms of transportation costs and delivery times. Blue ammonia is also a potential energy carrier for the hydrogen economy, as it can be easily converted back into hydrogen, which can be used in fuel cells or other applications. If compared to LNG, blue ammonia has the potential to offer higher value-added products and services than LNG. Blue ammonia can be used as a feedstock to produce high-value chemicals such as fertilizers, plastics, and pharmaceuticals, which can command higher prices in the global market. In addition, blue ammonia can be used as a low-carbon alternative to LNG in power generation and transportation, which can create new market opportunities.

Blue ammonia production requires more advanced technologies and infrastructure than LNG, which can increase its production costs and limit its market penetration. In addition, the global market for low-carbon fuels and chemicals is still developing, and the demand for blue ammonia may not be as high as for LNG in the short term.

Both blue ammonia and LNG have their competitiveness in Arab countries which will depend on a range of factors, including production costs, infrastructure, market demand, and policy support.

Several Arab countries are actively developing blue ammonia projects to capitalize on their abundant natural gas resources, reduce their carbon footprint, and diversify their economies.

These blue ammonia projects in Arab countries are expected to create new market opportunities for low-carbon fuels and chemicals, reduce greenhouse gas emissions, and support the transition to a low-carbon economy. They also highlight the importance of international partnerships and collaborations in the development and deployment of advanced technologies for sustainable development.

References:

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