

ADAPT CARBON DIOXIDE & HYDROGEN DRYING

OUR SERVICES



Carbon capture and the use of hydrogen as a clean fuel are becoming important considerations in the global action against climate change.

Carbon capture concerns the removal of carbon dioxide from process streams that would otherwise be vented and result in an undesirable increase in its atmospheric concentration due to its behaviour as a greenhouse gas. Hydrogen is considered as an attractive fuel to replace natural gas as it is clean burning with no carbon dioxide, only water vapour, produced during its combustion. In the applications of carbon capture and hydrogen production, various treatment steps are required including drying of the streams. DNV has a gas processing technology, ADAPT (Advanced Adsorption Process Technology), that has been commercially established in the process industries for over thirty years and it can be used for the drying of carbon dioxide and hydrogen streams.

Carbon Dioxide Drying

In the process industries, carbon dioxide is released into the atmosphere from various sources including:

- Flue gas from fossil fuel power plants and natural gas turbines
- Carbon dioxide removed from natural gas to meet process or pipeline requirements
- Carbon dioxide removed downstream of the steam methane reforming process during the production of synthesis gas or hydrogen

Where carbon dioxide is captured, it is usually extracted by liquid absorption technologies using chemical solvents (such as amines) or physical solvents (such as Selexol) for example. In these cases, the captured carbon dioxide is wet and therefore requires dehydration before it is transported by pipeline to its destination. If dehydration is not performed, condensation of water in the pipeline may occur and this could lead to undesirable two-phase flow that could affect pipeline operations and may also cause corrosion of the pipeline due to carbonic acid formation.

There are various gas treatment process technologies that can be used for the dehydration of carbon dioxide. The main techniques include liquid absorption processes (such as glycol) and solid bed adsorption processes (such as molecular sieve and silica gel). Solid bed adsorption

processes are advantageous for many reasons including the following:

- Risk of foaming and liquid entrainment to the downstream pipeline is eliminated
- Flexible to handle varying feed gas process conditions
- Exhibit excellent turndown capability
- Can achieve the treated gas specification immediately upon start-up
- High reliability and low maintenance requirements
- Lower atmospheric emissions

DNV has extensive experience with the use of solid bed adsorption processes and has provided the technology for high pressure natural gas dew point control plants using its proprietary ADAPT process. There are 16 commercial applications of ADAPT worldwide today including some of the world's most prestigious natural gas developments. These plants perform simultaneous drying of the natural gas and water is removed effectively on the silica gel adsorbent.

In addition to its primary application in the high pressure natural gas field, ADAPT can also be used for the dehydration of carbon dioxide and the techniques employed in the process are beneficial to optimising the plant requirements compared to alternative technologies.





Advantages of the techniques used in the ADAPT design for carbon dioxide drying include the following:

- Silica gel adsorbent - this adsorbent is a mechanically strong adsorbent, more robust in acid gas service than molecular sieve and this leads to longer adsorbent service life and the avoidance of dust formation due to adsorbent deterioration.
- Internally insulated towers - the tower itself is not subjected to the temperature cycling that is required for the continuous adsorption and regeneration cycle operation. This extends the tower operating life, saves on energy required for regeneration and allows shorter adsorption cycles with a reduced water removal requirement to be employed because the regeneration stage can be completed in a shorter time.
- Smaller towers - the shorter cycle times result in a lower loading of water on the adsorbent during the regeneration cycle and this allows less adsorbent and smaller towers to be employed. This allows savings on capex and a reduction in the quantity of adsorbent required.
- Smaller equipment count - the number of adsorber towers and switching valves required is less leading to a large reduction in the overall equipment count allowing savings in both capex and opex.
- No rotating machinery - the absence of compressors and pumps significantly improves plant availability and maintainability.

Hydrogen Drying

Hydrogen is manufactured by two principal methods, steam methane reforming and the electrolysis of water. In the case of steam methane reforming, a synthesis gas is produced containing hydrogen, carbon monoxide and some carbon

dioxide. Where only hydrogen is required as the product, the carbon monoxide is reacted in a shift converter to carbon dioxide and the latter is then removed. This is termed as a pre-combustion application for carbon capture and liquid absorption technologies using chemical solvents (such as hot carbonate systems like the Benfield process) or physical solvents (such as Selexol) are usually used. In pre-combustion liquid absorption applications and water electrolysis, the hydrogen stream produced will be wet and will require dehydration. Failure to perform dehydration will lead to the condensation of water in the pipeline that could lead to undesirable two-phase flow and corrosion.

ADAPT can be used for the dehydration of hydrogen and the techniques employed by the technology can be used to allow an optimised design solution for such plants. ADAPT will offer similar advantages in hydrogen drying to its application in carbon dioxide drying and the main features are highlighted as follows:

- Silica gel is a robust, mechanically strong adsorbent
- Internally insulated towers reducing regeneration energy requirement
- Smaller towers reducing capex and the amount of adsorbent required
- Smaller equipment count reducing capex and opex
- No rotating machinery required, improving plant availability and maintainability

Contact Us

If you have a requirement for the drying of carbon dioxide or hydrogen streams, please contact DNV for a solution based on ADAPT and let us provide you with an optimised solution that provides both technical and financial benefits based on established technology.



ABOUT DNV

DNV is an independent assurance and risk management provider, operating in more than 100 countries, with the purpose of safeguarding life, property, and the environment. As a trusted voice for many of the world's most successful organizations, we help seize opportunities and tackle the risks arising from global transformations. We use our broad experience and deep expertise to advance safety and sustainable performance, set industry standards, and inspire and invent solutions.

IN THE ENERGY INDUSTRY

We provide assurance to the entire energy value chain through our advisory, monitoring, verification, and certification services. As the world's leading resource of independent energy experts and technical advisors, we help industries and governments to navigate the many complex, interrelated transitions taking place globally and regionally, in the energy industry. We are committed to realizing the goals of the Paris Agreement, and support our customers to transition faster to a deeply decarbonized energy system.

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