THE DARWIN HELIUM FACILITY
OPERATION OF A HELIUM PURIFICATION, LIQUEFACTION AND DISTRIBUTION PLANT

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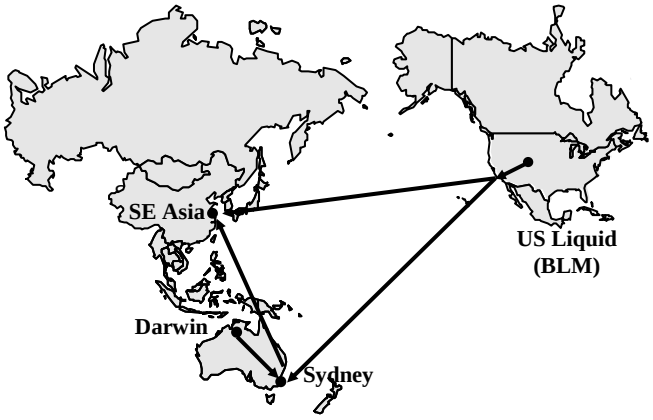
In 2006, BOC Gases Australia, a member of The Linde Group, decided to install a helium facility in Darwin, Australia, to extract helium from a nitrogen rich off-gas. The plant with a capacity of 2.5 tpd of liquefied helium was engineered and fabricated by Linde Kryotechnik AG and subsequently installed and commissioned in the second half of 2009.
The present paper describes the process concept of the plant, its drivers and benefits. Besides outlining the challenges imposed by the tight schedule and the turn-key lump sum project execution approach, the paper specifically focuses on the commissioning activities and initial operation.

BACKGROUND

Helium demand in Australia and South East Asia was so far covered by supplies from US-american sources, namely the Bureau of Land Management (BLM). The increasing helium demand on the one side and the projected long-term depletion of the BLM helium caverns on the other side, called for new helium sources, preferably in the South East Asian or Australian region to keep transportation routes short.



The East Timor sea located northwest of Australia is rich in natural gas reserves, some of them containing considerable amounts of helium. Darwin LNG Pty Ltd.'s facility, owned and operated by a joint venture of Conoco Philips, ENI SPA, Inpex Corporation, Santos and Tokyo

Gas / Tokyo Electric Corporation, liquefies gas from a field 500 km north of Darwin for supply mainly to the Japanese market. With the plant commencing operation in early 2006, a helium rich waste stream became available, eventually starting the first helium plant project in the southern hemisphere realized by The Linde Group. Located just adjacent to Darwin LNG's facilities, the plant design had to consider tropical design conditions with a rainy cyclone prone season from December to April

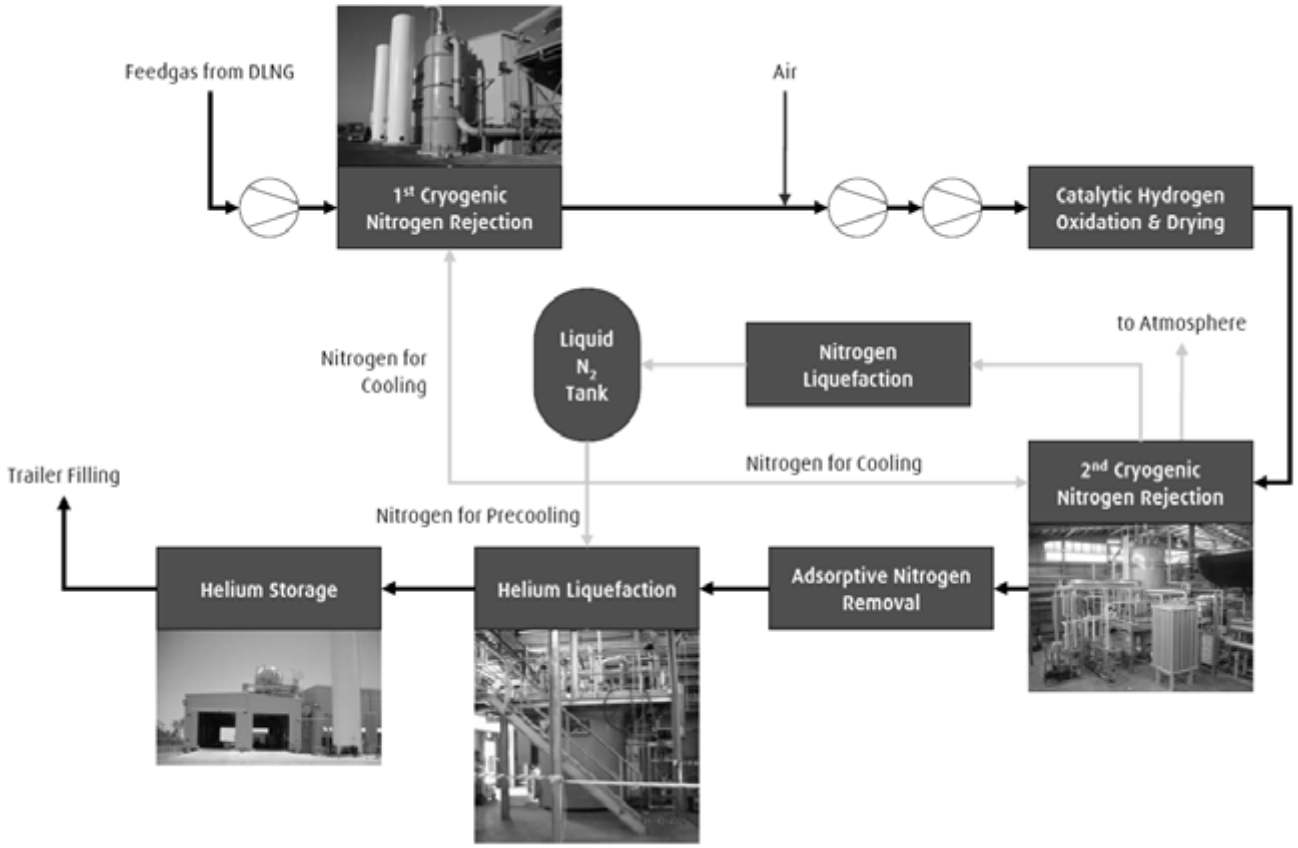
With technology supply and installation by Linde Kryotechnik AG, a subsidiary of Linde Engineering, and operation by BOC Gases Australia, supply and operation merged into one hand under

the umbrella of The Linde Group ensuring an optimal approach to project planning, execution, commissioning, and start-up.

THE PROCESS CONCEPT

Process design was driven by the objective to minimize power consumption and, more importantly, maximize helium recovery. Plant design bases on a nameplate capacity of 860 l/h of helium with a purity of 99.999 mol.%.

The feedgas, a nitrogen rich stream with a helium content of approximately 3 mol.%, is provided by Darwin LNG under a supply agreement based on Minimum-Take-Or-Pay (MTOP) terms. After pipeline transport over a distance of roughly one kilometre, metering, and initial compression, the bulk of the nitrogen is removed in the first cryogenic stage operating a liquid nitrogen temperature and increasing the helium content to 25 mol.%.



As the feed gas contains traces of hydrogen, further processing requires catalytic oxidation with air and subsequent drying. The helium content is then further enriched to 99 mol.% in a second cryogenic stage, again operating at liquid nitrogen temperature. This separation step is simultaneously used to generate high purity nitrogen which – after liquefaction in a dedicated coldbox – is used to provide the cold for the cryogenic separation processes as well as for nitrogen precooling for helium liquefaction.

Adsorption removes the remaining impurity traces. The purified helium is finally liquefied applying a modified Brayton cycle with three expansion turbines and then routed to the helium storage atop of the helium filling facility.

PROJECT EXECUTION CHALLENGES

Besides the complex process scheme, the project depicted further characteristics which rendered project execution particularly challenging. Due to the greenfield installation, activities were not limited to the process plant itself, but included civil works and supply of utilities, resulting in a truly lump-sum turnkey project.

The tight financial budget and the short project execution period of 24 months from contract signing to initial start-up were aggravated by the worldwide economic hype. Procurement and subcontracting activities concentrated at end of 2007, beginning of 2008 when price levels peaked at historically high levels. Namely construction activities suffered from the tight worldwide manpower availability with even more severe conditions in Australia, particularly at the remote project location.

The execution challenges were accompanied by restrictions during commissioning. Utility supply proved to be unreliable prior to start-up with frequent interruptions in power supply. The remote location of Darwin with regard to readily accessible infrastructure called for accurate planning to ensure timely availability of liquid nitrogen and helium on site for cool-down and start-up.

Finally, delayed availability of feed gas from the LNG complex and limitations in feed gas methane content to avoid hazardous situations at the first nitrogen removal unit impacted the commissioning schedule towards the end of project execution.

COMMISSIONING AND START-UP

Above all, the joint and cooperative planning of all construction and commissioning activities between Linde Kryotechnik AG and BOC Gases Australia helped to offset the challenges to a high degree, minimized delays and led to an excellent HSE result. Linde Kryotechnik AG ensured continuous support with dedicated supervisors for process design, machinery, electrical engineering, controls, and commissioning.

Commissioning could successfully be completed end of December 2009. Cool-down started immediately afterwards in the first week of January 2010 with the first drop of helium produced only 2 weeks later. Even though the plant had to be stopped for two weeks end of January due to lack of feedgas, the first helium container eventually left Darwin on February 11th, 2010 – a great success proving that intensive and diligent commissioning activities finally pay-off by a smooth start-up.

SUMMARY

Despite the challenges induced by financial constraints, tight project schedule, impact of the overheated worldwide economy and the remote location, the Darwin helium facility turned out to be a great success story. Diligent planning and, more importantly, the excellent cooperation between the customer, BOC Gases Australia, and the supplier, Linde Kryotechnik AG, resulted in a highly effective project execution, thorough commissioning and best-in-class start-up.

The Darwin helium facility is now successfully in operation for more than 6 months. Helium supply into the Australian and South East Asian markets has since become less dependent from US-american supply and pricing, and has eventually rendered this first facility in the southern hemisphere an exceptional success story.