Facility Inspection Report

Oxygen Plant (Air Separation Unit)
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Executive Summary

• This 1,782 mt/day oxygen plant was installed in 2000 and recently shut down at the beginning of 2013.

• Spare parts for this facility are abundant and include a spare 25 MW electric motor for the main air compressor.

• Documentation is excellent in both paper and electronic formats. All types of documentation were reviewed and found acceptable during the inspection. We have electronic copies of PFDs, major equipment data sheets, major equipment manufacturers’ drawings, mass balances, detailed equipment lists, plot plans, process descriptions, and historical production data.

• Process control is by ABB Advant DCS and is available with the sale of the plant.

• There is no asbestos in this facility due to its recent construction.

• The site has good rail and truck access. It is located directly on the ocean and has its own harbor. Equipment removed from this facility can be loaded directly on barges at the facility shoreline, since this is how the equipment was delivered.
Process Description

This air separation unit (ASU) produced oxygen necessary for a gasification facility. The operation is based on the traditional principle of fractionated distillation of liquid air.

The oxygen from the Praxair licensed facility is greater than 95% purity and is produced at 76 bar and 132°C. The nitrogen is produced at 36 bar and 50°C. The “warm side” of the ASU (mainly compressors) is located indoors with a 60 mt overhead crane. The “cold side” is located outdoors in an enclosed cold box.

This Air Separation Unit can undergo some rather simple modifications to achieve 98% oxygen purit. To achieve 99+% purity for chemical use, a fourth distillation column would need to be added to remove argon from the oxygen product. While this will add to project and operation costs, the argon can be sold to defray some of the costs.

The large, main air compressor is a four-stage Sulzer centrifugal unit with a 23 MW ABB electric drive motor. It compresses enough air to produce 1,782 mt/day of 95% pure oxygen. The compressed air is cooled with two absorption refrigeration units (ARU using lithium bromide solution).

The compressed air is cooled and then purified with a two-bed alumina/molecular sieve dual-absorbent pre-purifier system which remove any remaining water vapor and contaminants such as carbon dioxide. One pre-purifier is in service while the other is being regenerated with hot nitrogen. The switching and operation of the pre-purifiers is automatically controlled.
The air is then sent to the booster air compressor for additional compression. The booster air compressor in this ASU is a Borsig unit driven by a 3.1-MW ABB electric motor. It has a capacity of 70,000 Nm³/hr, boosting the air pressure from 8.2 to 22.5 bar. The Renk gearbox increases the drive speed to 17,000 rpm.

The air is now cooled to cryogenic temperatures for liquefaction and subsequent distillation into the oxygen and nitrogen components. It is first cross-exchanged with the cold oxygen and nitrogen product streams. This lowers the temperature to -166°C. Next it is further cooled to -175°C with low pressure nitrogen from the nitrogen superheater. The cooled air is then fed to three columns in series; the high-pressure air separation column, the intermediate-pressure air separation column, and the low-pressure air separation column. The first column separates gaseous nitrogen and an oxygen rich liquid at 7 bar and -168°C. The bottoms liquid stream is fed to the second column, which continues the separation of nitrogen and oxygen at 4.3 bar. The liquid bottoms stream from the second column is fed to the third column, which operates at 1.3 and -187°C for the final separation. The cryogenic exchangers and columns are all housed in the cold box which is packed with perlite insulation.
The final oxygen product is delivered from the coldbox at 4.7 bar. A portion of the stream is compressed to 76 bar for use in the high-pressure gasifiers. The oxygen compressor is a Sulzer three-stage unit with six impellers. It has a 5.5-MW ABB motor turning at 1482 rpm driving a Renk gearbox that spins the compressor at 15,000 rpm. The compressor is rated for 50,000 Nm³/hr with 90 bar discharge pressure (normal operation is 76 bar).

The nitrogen compressor is a five-stage Borsig machine driven by a 10.8 MW ABB electric motor. The Renk gearbox has three output shafts that turn at speeds from 14,000 to 17,000 rpm. The complex compressor has two suction lines and takes the nitrogen pressure from 12 to 38 bar. However, the machine is rated for a maximum of 55 bar. It pumps nitrogen at 41,000 Nm³/hr or 38 kg/sec.

The high-pressure nitrogen product is expanded through a generator loaded nitrogen turbo-expander to recover the energy. The unit is capable of handling 950,000 ft³/hr turning at 6,250 rpm. The generator is rated for 400 hp turning at 3020 rpm. It produces electricity at 380 V and 50 Hz. The electricity is used for refrigeration in the cryogenic section. The nitrogen is then used for dilution in the gas turbine feedstream.