Immingham Green Energy Terminal

Preliminary Environmental Information Report

Appendix 2.A: Hydrogen Production Process

Associated British Ports

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1 Process Overview

1.1 Hydrogen Production Unit

1.1.1 The ammonia feed flows through a series of heat exchangers, which pre-heat and vaporise the ammonia, before entering the reaction section. The ammonia is reacted endothermically to produce nitrogen and hydrogen in a catalyst-filled reactor. Pre-heating of the ammonia is provided by heat integration with the rest of the process.

1.1.2 The production unit consists of catalyst filled tubes inside a fired furnace. The catalyst facilitates the ammonia to hydrogen reaction. Additional heat exchangers are in the furnace convection section to recover energy from the flue gas. The convection section also includes heat exchange coils for pre-heating the feed streams of the process.

1.1.3 Initially the primary fuel source for the furnace would be natural gas, which is supplemented with tail gas from the PSA unit to reduce the carbon intensity of the process. The convection section includes an SCR (Selective Catalytic Reduction) unit to reduce nitrogen oxides (NOx) to an acceptable level before discharging to the atmosphere. The unit is operated between 30 and 50 barg, as this hydrogen is required at elevated pressure for downstream uses.

1.1.4 The hydrogen leaving the reaction section must be purified before being sent to the pipeline and liquefier. A pressure swing absorber (PSA) unit is located downstream of the unit and is designed to produce high purity H2. The PSA consists of multiple beds which operate in cycles. The tail gas is recycled to the furnace burners to reduce the natural gas demand and the carbon intensity of the process.

1.1.5 Most of the purified hydrogen gas leaving the PSA unit is sent to the liquefaction trains.

1.1.6 Because sources of biogas may not be available initially to provide the heating duty requirements, the process will be initially fuelled with natural gas.

1.2 Hydrogen Liquefaction

1.2.1 The hydrogen liquefier is designed to produce >30 tonne/day of liquid hydrogen to load liquid hydrogen trailers. Cryogenic adsorbers are included at the front end of the process to remove trace levels of (nitrogen) N_2, argon (Ar), carbon monoxide (CO) and methane (CH_4) from the feed gas before it is liquefied, which is common practice for liquid hydrogen plants as these components would freeze within the liquefier.

1.2.2 There are three primary circuits in the process, described in the following sections.

Hydrogen Feed Circuit

1.2.3 Prior to liquefaction, the feed gas is cooled below 100 K in the Warm Exchanger and passes across the Feed Gas Adsorbers, which are designed to remove N_2, Ar, CO and CH_4 from the feed gas.

1.2.4 Regeneration is performed by de-pressuring and warming the vessel to desorb the adsorbed contaminants. After removal of trace contaminants, the feed gas is passed across the first catalyst bed. Because this equipment operates above 80 K, it is installed in a nitrogen-purged cold box.

1.2.5 The feed gas is subsequently cooled down below 40 K in another heat Exchanger. As the feed gas cools, it is passed across catalyst beds and through a further heat exchanger.

1.2.6 The flashed vapour stream is recycled to the process feed.

Hydrogen Recycle Circuit

1.2.7 The purified hydrogen is cooled by progressively expanding it in steps across three expanders in series with additional intercooling through a Heat Exchanger.

1.2.8 The final expander discharge is then reheated in a Heat Exchanger providing the refrigeration duty necessary to cool the feed gas and the hydrogen recycle stream. After warming to ambient temperature, the expander discharge is recovered in the Recycle Compressor.

Nitrogen Circuit

1.2.9 The refrigeration necessary to cool the hydrogen feed and recycle gas down below 100 K is provided by expanding high pressure nitrogen across expanders.