Immingham Green Energy Terminal

TR030008

Volume 6

6.4 Environmental Statement Appendices

Appendix 2.C: Hydrogen Production Process

Planning Act 2008

Regulation 5(2)(a)

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (as amended)

September 2023

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (as amended)

Immingham Green Energy Terminal

Development Consent Order 2023

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Appendix 2.C: Hydrogen Production Process

Regulation Reference	APFP Regulation 5(2)(a)
Planning Inspectorate Case Reference	TR030008
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Revision 1	21 September 2023	DCO Application

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Chapter Pages

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 it is reacted endothermically to produce nitrogen (N_2) and hydrogen (H_2) in a catalyst-filled fired heater.

1.1.2 The hydrogen production unit consists of catalyst filled tubes inside a fired heater. The catalyst facilitates the ammonia to hydrogen reaction. Additional heat exchangers are in the fired heater convection section to recover energy from the flue gas before it is emitted through the flue gas stack. The convection section also includes heat exchanger coils for pre-heating the ammonia feed streams entering the fired heater.

1.1.3 The convection section also includes process equipment to reduce nitrogen oxides (NO_x) to an acceptable level before discharging to the atmosphere. The unit is operated between 30 and 50 barg, as the hydrogen is required at elevated pressure for downstream uses.

1.1.4 The H_2 leaving the reaction section of the fired heater must be purified before being sent to the liquefier. Process equipment called a pressure swing absorber ("PSA") unit is located downstream of the fired heater and is designed to produce high purity H_2. The tail gas, which is a waste stream from the PSA, is recycled to the fired heater burners to reduce the natural gas demand and the carbon intensity of the process.

1.1.5 The purified hydrogen gas leaving the PSA unit is sent to the hydrogen liquefier units.

1.1.6 Initially the primary fuel source for the fired heater would be natural gas, which is supplemented with tail gas from the PSA unit to reduce the carbon intensity of the process. The fired heater will initially be fuelled with natural gas because sources of renewable biogas may not be available initially to provide the heating duty requirements.

1.2 Hydrogen Liquefier

1.2.1 The hydrogen liquefier receives gaseous hydrogen from the hydrogen production unit, purifies it and refrigerates it into liquid form.

1.2.2 There are three primary circuits in the hydrogen liquefier unit, described in the following sections.

Hydrogen Feed Circuit

1.2.3 Prior to liquefaction, the H_2 is cooled below 100K in a heat exchanger and then passed into a process equipment unit called a Feed Gas Cryogenic Adsorbers, which removes impurities such as trace levels of N_2, argon (Ar), carbon monoxide (CO) and methane (CH_4) .

1.2.4 The cryogenic adsorber beds are regenerated periodically de-pressuring and warming the vessel to release the contaminants.

1.2.5 After removal of trace contaminants, the hydrogen is passed across the first catalyst bed in a nitrogen-purged cold box.

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

1.2.7 The flashed hydrogen vapour stream is recycled back to the hydrogen feed into the liquefier unit.

Hydrogen Recycle Circuit

1.2.8 The purified hydrogen is cooled by progressively expanding it in steps across three expanders in series with additional intercooling through a heat exchanger.

1.2.9 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

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