HyNet Hydrogen Production Plant 1 – Technical Note

EPR Response – 2C: Operating Techniques and BAT for the Flare

Summary

Background

The flare design and operation are described in Application paras 2.3.32 – 2.3.37.

A feed of 100% hydrogen is not discussed, nor is it one of the design cases listed on the Equipment (Document No. 5194812-000-45ED-4-0004). The highest H_2 concentration is shown as 74% for Case 3 (Max CO_2 Relief).

Problem Statement

Explain whether the flare is designed to accept a feed of hydrogen alone if necessary and describe any special design features for the flare tip to safely combust hydrogen.

Action

Kent to confirm the maximum hydrogen case and advise on tip features as required.

Response

Existing Project Details

The flare duty cases are outlined in Fig. 1 and Fig. 2, taken from the project datasheet (Document No. 5194812-000-45ED-4-0004).

As can be seen, the case which contains the maximum concentration of Hydrogen is Case 3 of the Warm/Wet Riser. The concentration is 73.49 mol% Hydrogen. Therefore the flare is not required to combust a stream containing 100% hydrogen.

Kent confirm that these are the only duty cases for the flare at this time and are based on FEED data available.

5	PROCESS DESIGN CONDITIONS (WARM/WET RISER - 10-CAA-D-001 TIP - 10-CAA-D-002) (Note M14 & M17)						
6	**Case Description**			**Case 1 Maximum Blowdown Case**	**Case 2 Maximum Temperature**	**Case 3 Maximum CO2 Relief**	**Case 4 Maximum CO2 Compos.**
7	Smokeless Operation Required (Yes / No)			**YES**	**YES**	**YES**	**YES**
8	Flow Rate		kg/hr	**221,968**	**79,511**	**151,700**	**17,940**
9	Density		kg/m^3	**1.00**	**0.64**	**0.95**	**2.56**
10	Molecular Weight		g/mol	**14.42**	**18.02**	**12.55**	**39.33**
11	Net Heating Value (LHV)		KJ/kgmole	**302,000**	**0**	**-181,000**	**0**
12	Ratio of Specific Heats @ P & T (Cp/Cv)						
13	Supply Pressure @ Base of Stack		bara	**2.30**	**2.060**	**2.100**	**2.1**
14	Gas Temperature		°C	**127.6**	**424.0**	**60.0**	**117.0**
15	GAS COMPOSITION (Mol% on Wet Basis)						
16	Hydrogen	H2	mol%	**30.85**	**0.00**	**73.49**	**0.00**
17	Nitrogen	N2	mol%	**0.05**	**0.00**	**1.34**	**0.00**
18	Carbon Dioxide	CO2	mol%	**6.21**	**0.00**	**23.52**	**82.00**
19	Methane	CH4	mol%	**25.72**	**0.00**	**0.21**	**0.00**
20	Ethane	C2H6	mol%	**1.33**	**0.00**	**0.00**	**0.00**
21	Ethylene	C2H4	mol%	**0.00**	**0.00**	**0.00**	**0.00**
22	Propylene	C3H8	mol%	**0.00**	**0.00**	**0.00**	**0.00**
23	Propane	C3H8	mol%	**0.00**	**0.00**	**0.00**	**0.00**
24	i-Butane	C4H10	mol%	**0.00**	**0.00**	**0.00**	**0.00**
25	n-Butane	C4H10	mol%	**0.00**	**0.00**	**0.00**	**0.00**
26	i-Pentane	C5H12	mol%	**0.00**	**0.00**	**0.00**	**0.00**
27	n-Pentane	C5H12	mol%	**0.00**	**0.00**	**0.00**	**0.00**
28	Carbon Monoxide	CO	mol%	**0.68**	**0.00**	**0.45**	**0.00**
29 30	Water	H2O	mol%	**35.17 (AS VAPOUR)**	**100 (AS VAPOUR)**	**0.94 (AS VAPOUR)**	**18.00 (AS VAPOUR)**
31	Methanol	CH3OH	mol%	**0.0000**	**0.00**	**0.05**	**0.00**
32	H2S	H2S	ppmv	**-**	**-**	**-**	**-**
33	Total Heat Release:		kJ/hr	**STA**	**STA**	**STA**	**STA**
34	Flare Tip Exit Velocity:		m/s	**STA**	**STA**	**STA**	**STA**
35	Mach Number:		--	**0.5 (MAXIMUM)**	**0.5 (MAXIMUM)**	**0.5 (MAX)**	**0.5 (MAX)**

Fig. 1: Duty Cases for the Warm Wet Riser.

5	PROCESS DESIGN CONDITIONS (COLD/DRY RISER - 10-CAA-D-003 TIP - 10-CAA-D-004) (Note M17)						
6	Case Description			Case 1 Maximum Blowdown Case (Note M16)			
7	Smokeless Operation Required (Yes / No)			YES			
8	Flow Rate		kg/hr	60,434			
9	Density		kg/m^3	2.16			
10	Molecular Weight		g/mol	18.02			
11	Net Heating Value (LHV)		KJ/kgmole	-837,800			
12	Ratio of Specific Heats @ P & T (Cp/Cv)						
13	Supply Pressure @ Base of Stack		bara	2.03			
14	Gas Temperature		°C	-46			
15	GAS COMPOSITION (Mol% on Wet Basis)						
16	Hydrogen	H2	mol%	0.00			
17	Nitrogen	N2	mol%	0.89			
18	Carbon Dioxide	CO2	mol%	2.00			
19	Methane	CH4	mol%	89.00			
20	Ethane	C2H6	mol%	7.00			
21	Ethylene	C2H4	mol%	0.00			
22	Propylene	C3H8	mol%	0.00			
23	Propane	C3H8	mol%	1.00			
24	i-Butane	C4H10	mol%	0.00			
25	n-Butane	C4H10	mol%	0.10			
26	i-Pentane	C5H12	mol%	0.01			
27	n-Pentane	C5H12	mol%	0.00			
28	Carbon Monoxide	CO	mol%	0.00			
29 30	Water	H2O	mol%	0.00			
31	Methanol	CH3OH	mol%	0.00			
32	H2S	H2S	ppmv	-			
33	Total Heat Release:		kJ/hr	STA			
34	Flare Tip Exit Velocity:		m/s	STA			
35	Mach Number:		--	0.5 (MAXIMUM)			

Fig. 2: Duty Case for the Cold Dry Riser.

FEED Vendor Proposals

During the FEED Phase of the project, proposals were received from two (2) vendors as follows:

- Zeeco Europe, and,
- GBA Flare Systems.

Since there are no cases that require 100% Hydrogen combustion, the Vendors did not design the flares to accept this case. However, GBA Flare Systems advised that they had extensive experience in syngas and high hydrogen concentration flares, so Kent approached them for additional information.

GBA Flare Systems advised that 100% hydrogen combustion is possible, but the absolute line velocities need to be addressed, as they can get very fast and the usual mach number limits have to be ignored. The present tip on the proposed flare for the project is 36” diameter, expanded from a 30” diameter riser to keep the Warm/Wet Case 1 exit velocity down to a reasonable level. This would have to be reviewed if a 100% hydrogen case was introduced.

In addition, noise will be a factor a 100% hydrogen case is introduced and a detailed noise assessment will have to be carried out post purchase order award to ensure this is kept to an acceptable level.

Updates to Design

None required. There are no cases requiring 100% hydrogen combustion and so the flare does not need to be designed for this.