Supplementary Material

Life cycle assessment of plasma-assisted ethylene production from rich-in-methane gas streams

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Table S-1 Heat and additional CO_2 emissions released when the purge stream is totally flared in the one-step plasma-assisted process.

Element	Purge (mol/h)	V-101 top (mol/h)	ΔHc (kJ/mol)	Heat release ($MJ/kg_{ethylene}$)	CO_2 release ($kgCO_2/kg_{ethylene}$)	H_2O release ($kgH_2O/kg_{ethylene}$)
H_2	2124.5		286	6.8	0.0	0.43
CH_4	1434.7	4.9	891	14.4	0.71	0.6
C_2H_6	0.4	4.6	1561	0.09	0.005	0.003
C_2H_4	10.1		1387	0.2	0.01	0.0041
C_2H_2	0.04		1300	0.001	0.000043	0.00001
Total	3569.8			21	0.73	1.02
Combustion reactions:	$H_2 + ½O_2 \rightarrow H_2O$		$C_2H_2 + 2½O_2 \rightarrow 2CO_2 + H_2O$			
	$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$		$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$			
	$C_2H_6 + 3½O_2 \rightarrow 2CO_2 + 3H_2O$					

Table S-2 Heat and additional CO_2 emissions released when the purge stream is partially flared in the one-step plasma-assisted process.

Element	Purge (mol/h)	ΔHc (kJ/mol)	Heat release ($MJ/kg_{ethylene}$)	CO_2 release ($kgCO_2/kg_{ethylene}$)	H_2O release ($kgH_2O/kg_{ethylene}$)
H_2	424.89	286	1.4	0.0	0.09
CH_4	286.94	891	2.9	0.142	0.12
C_2H_6	0.08	1561	0.00	0.000081	0.00005
C_2H_4	2.03	1387	0.0	0.002	0.0008211
C_2H_2	0.01	1300	0.000	0.0000087	0.000002
Total	713.95		4.3	0.144	0.203

Table S-3 Heat and additional CO_2 emissions released when the purge stream is totally flared in the two-step plasma-assisted process.

Element	Purge (mol/h)	V-101 top (mol/h)	ΔHc (kJ/mol)	Hot utility ($MJ/kg_{ethylene}$)	CO_2 release ($kgCO_2/kg_{ethylene}$)	H_2O release ($kgH_2O/kg_{ethylene}$)
H_2	2123.88		286	5.5	0	0.35
CH_4	1488.88	neglected	891	12.11	0.6	0.49
C_2H_6	0.32		1561	0.00	0.0003	0.0002
C_2H_4	6.07		1387	0.1	0.005	0.002
C_2H_2	0.02		1300	0.0003	0.00002	0.000004
Total	3619.16			17.7	0.6035	0.8414

Table S-4 Product and byproducts market price used for the economic allocation factor calculation.

Product	Price $/ton
H_2	310
C_2H_4	1200
C_2H_6	388
C_2H_2	650
Natural gas	220