Appendix A for:

Exploring the feasibility of producing sustainable aviation fuel in the UK using hydrothermal liquefaction technology: A comprehensive techno-economic and environmental assessment

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Table A.1: Hydrotreating of biocrude reactions based on model compounds

Reaction Number	**Reaction**	**Stoichiometric Reaction**
1	Oleic acid + Hydrogen → Octadecene + Water	$C_{18}H_{34}O_2 + 3H_2 \rightarrow C_{18}H_{36} + 2H_2O$
2	Benzenetriol + Hydrogen → Cyclohexane + Water	$C_6H_6O_3 + 6H_2 \rightarrow C_6H_{12} + 3H_2O$
3	Furaldehyde + Hydrogen → Cyclopentane + Water	$C_5H_4O_2 + 6H_2 \rightarrow C_5H_{10} + 2H_2O$
4	Trihydroxybutanol + Hydrogen → Butane + Water	$C_4H_8O_2 + 4H_2 \rightarrow C_4H_8 + 4H_2O$

Table A.2: Plant Operating Costs for the Base Case

Stream	Consumption	Units	Costs	Units	Cost (£ million y^{-1})
Algae Feedstock [(a)]	1.31	tonne/hr	370	£/tonne	3.86
Electricity	72.0	kW	0.11	£/kWh	0.06
Hydrogen	47.2	kg/hr	1.57	£/kg	0.59
Upgrading Catalyst	3.25	tonne	57	£/kg	0.09
Quicklime	2940	tonne	92.4	£/tonne	0.27
Wastewater fee	8.74	tonne/hr	0.41	£/tonne	0.03
Water make up	8.60	tonne/hr	0.19	£/tonne	0.01
Heating Utility (steam)	8.71	tonne/hr	6.2	£/tonne	0.43
Cooling utility (water)	223	tonne/hr	0.003	£/tonne	0.005
Total Variable Operating Costs					5.36
Total Fixed Operating Costs					1.81
Total Operating Costs					7.17

(a) Dry weight of feedstock excluding ash content

Table A.3: Emission factors used for the carbon footprint assessment.

Component	Specific Emission Factor
Steam Heating (kg CO_2/kWh)	0.174
Mixed refinery gas (kg CO_2 /kWh)	0.25
Electricity (kg CO_2/kWh)	0.365
Transportation (g CO_2/kg km)	0.1398
Jet Engine Combustion (kg CO_2/kg fuel)	2.79
Absorbed by Algae (kg CO_2/kg algae)	2.72
Food waste Landfill Emissions (kg CO_2/kg food)	1.90
WWTP Emissions (kg CO_2/ kg sludge)	2.95

Table A.4: CEPCI used for inflation of installation costs of equipment

Year	CEPCI
1995	381.1
1996	381.7
1997	386.5
1998	389.5
1999	390.6
2000	394.1
2001	394.3
2002	395.6
2003	402
2004	444.2
2005	468.2
2006	499.6
2007	525.4
2008	575.4
2009	521.9
2010	550.8
2011	585.7
2012	-
2013	583.7
2014	586.77
2015	592
2016	606
2017	623.5
2018	638.1
2019	652.9
2020	668

Wastewater Treatment Section

As mentioned in the process description in Section 2.1, the AP fraction requires waste water treatment before being discharged to headworks to comply with environmental regulations on ammonia content and COD (Chemical Oxygen Demand). Figure 3.4 shows the design of the AP treatment section of the base case plant.

Lime treatment raises the pH of the aqueous stream to shift the equilibrium of ammonia towards the gas phase, which is then contacted with an air stripper to remove not only the ammonia gas but also volatile oxygenates (e.g. ethanol and acetic acid). The resulting aqueous stream is then safe to send to headworks. The ammonia/air stream is treated with a thermal oxidiser where ammonia and organics are catalytically combusted to N_2, CO_2 and H_2O and released to the atmosphere.

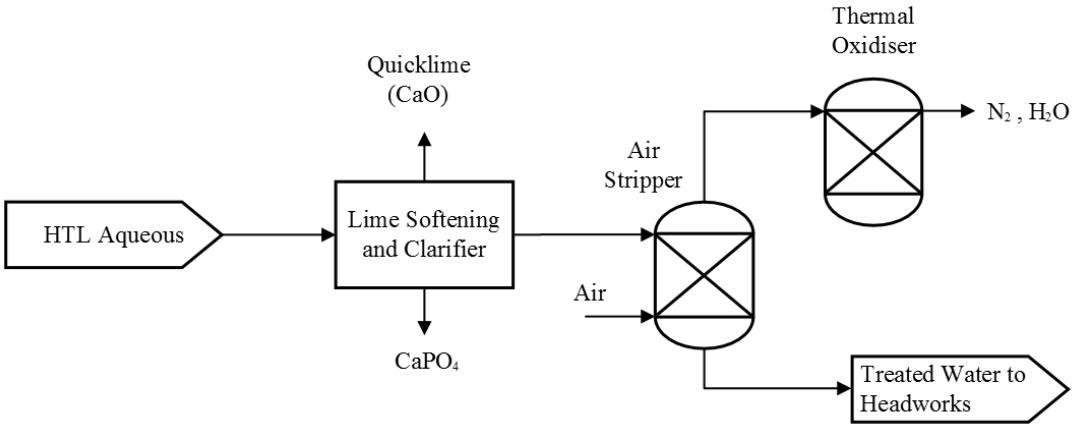

Figure A.1: Flow diagram of the Wastewater treatment section of the Plant used to treat the aqueous phase effluent from the reactor