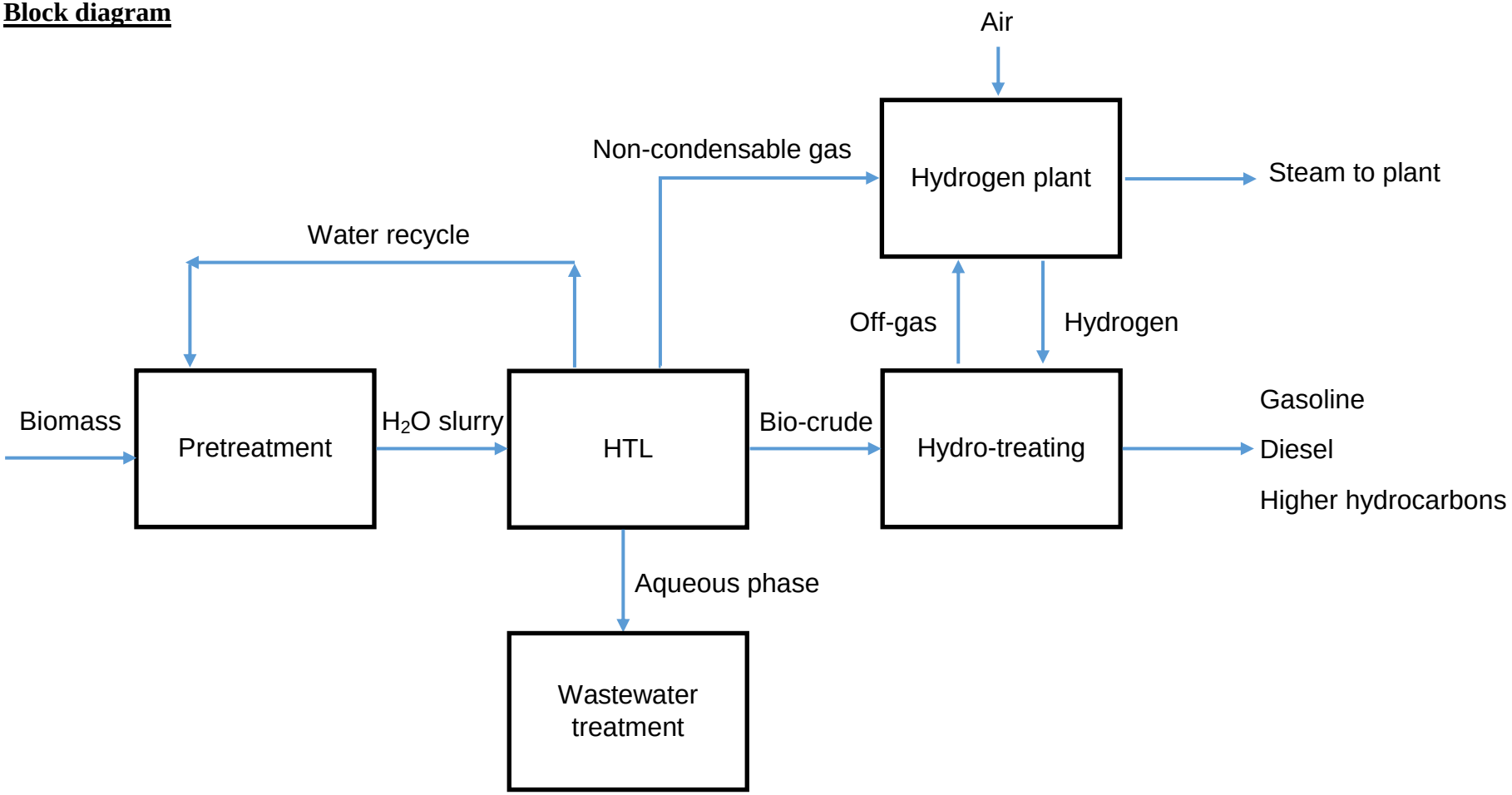
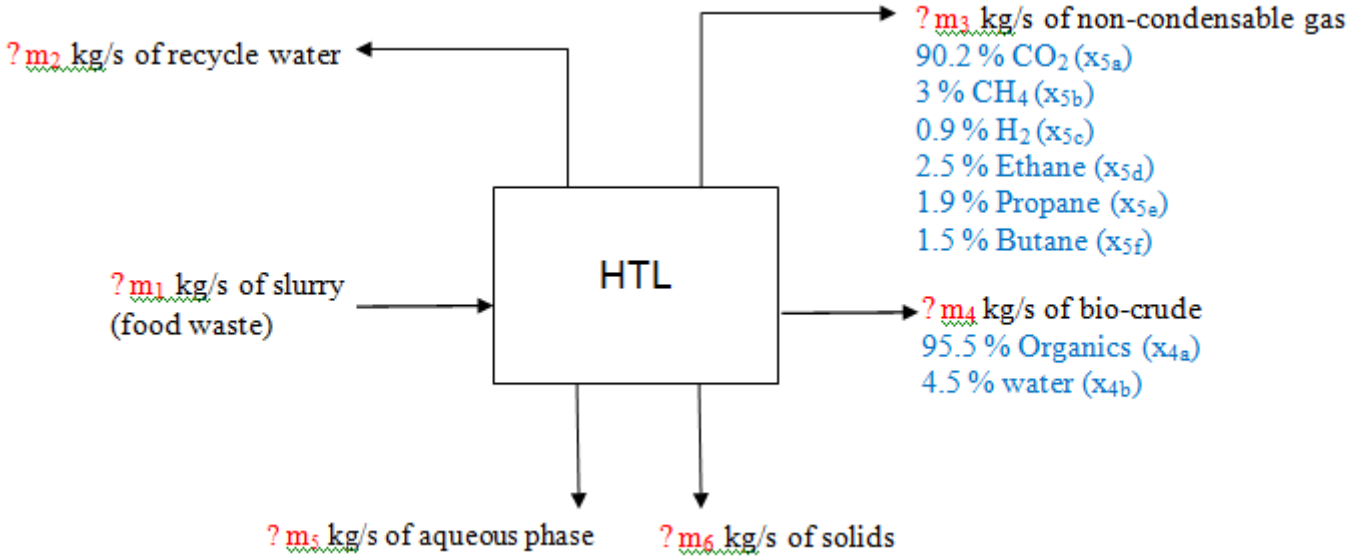
Block diagram



Mass balance

Based on (C.Elliott, 2012), the liquid hydrocarbon/biomass yield in hydrothermal pyrolysis is between 26-37 wt%. This is also supported by (U.S. Department of Energy, 2014) which stated that bio-crude yield is 34.6% while the yield of other products of hydrothermal liquefaction are stated as following:

Products	mass
Organic portion of Biocrude	34.6
Organics in Aqueous Phase	35.4
Solids	5.7
Reaction Water	6.8
Gas	17.5



Basis: 100 kg/s of feed produced by TESCO

Overall mass balance

$$\dot{m}_1 = \dot{m}_2 + \dot{m}_3 + \dot{m}_4 + \dot{m}_5 + \dot{m}_6$$

Mass balance for recycle water/ reaction water

$$\dot{m}_2 = \frac{100kg}{s} \times \frac{6.8}{100} = 6.8\frac{kg}{s}$$

Mass balance for non-condensable gas

$$\dot{m}_3 = \frac{100kg}{s} \times \frac{17.5}{100} = 17.5\frac{kg}{s}$$

$$x_{5a} + x_{5b} + x_{5c} + x_{5d} + x_{5e} + x_{5f} = 1$$

$$\dot{m}_{CO_2} = x_{5a}\,\dot{m}_5$$

$$= 17.5\frac{kg}{s} \times \frac{90.2}{100} = 15.79\frac{kg}{s}$$

$$\dot{m}_{CH_4} = x_{5b}\,\dot{m}_5$$

$$= 17.5\frac{kg}{s} \times \frac{3}{100} = 0.53\frac{kg}{s}$$

$$\dot{m}_{H_2} = x_{5c}\,\dot{m}_5$$

$$= 17.5\frac{kg}{s} \times \frac{0.9}{100} = 0.16\frac{kg}{s}$$

$$\dot{m}_{ethane} = x_{5d}\,\dot{m}_5$$

$$= 17.5\frac{kg}{s} \times \frac{2.5}{100} = 0.48\frac{kg}{s}$$

$$\dot{m}_{propane} = x_{5e}\,\dot{m}_5$$

$$= 17.5\frac{kg}{s} \times \frac{1.9}{100} = 0.33\frac{kg}{s}$$

$$\dot{m}_{butane} = x_{5f}\,\dot{m}_5$$

$$= 17.5\frac{kg}{s} \times \frac{1.5}{100} = 0.27\frac{kg}{s}$$

Mass balance for bio-crude

$$\dot{m}_4 = 100\frac{kg}{s} \times \frac{34.6}{100} = 34.6\frac{kg}{s}$$

$$x_{4a} + x_{4b} = 1$$

$$\dot{m}_{organics} = x_{4a}\,\dot{m}_4$$

$$= \frac{34.6kg}{s} \times \frac{95.5}{100} = 33.04\frac{kg}{s}$$

$$\dot{m}_{H_2O} = x_{4b}\,\dot{m}_4$$

$$=34.6\frac{kg}{s} - 33.04\frac{kg}{s} = 1.56\frac{kg}{s}$$

Mass balance for aqueous phase

$$\dot{m}_5 = \frac{100kg}{s} \times \frac{35.4}{100} = 35.4\frac{kg}{s}$$

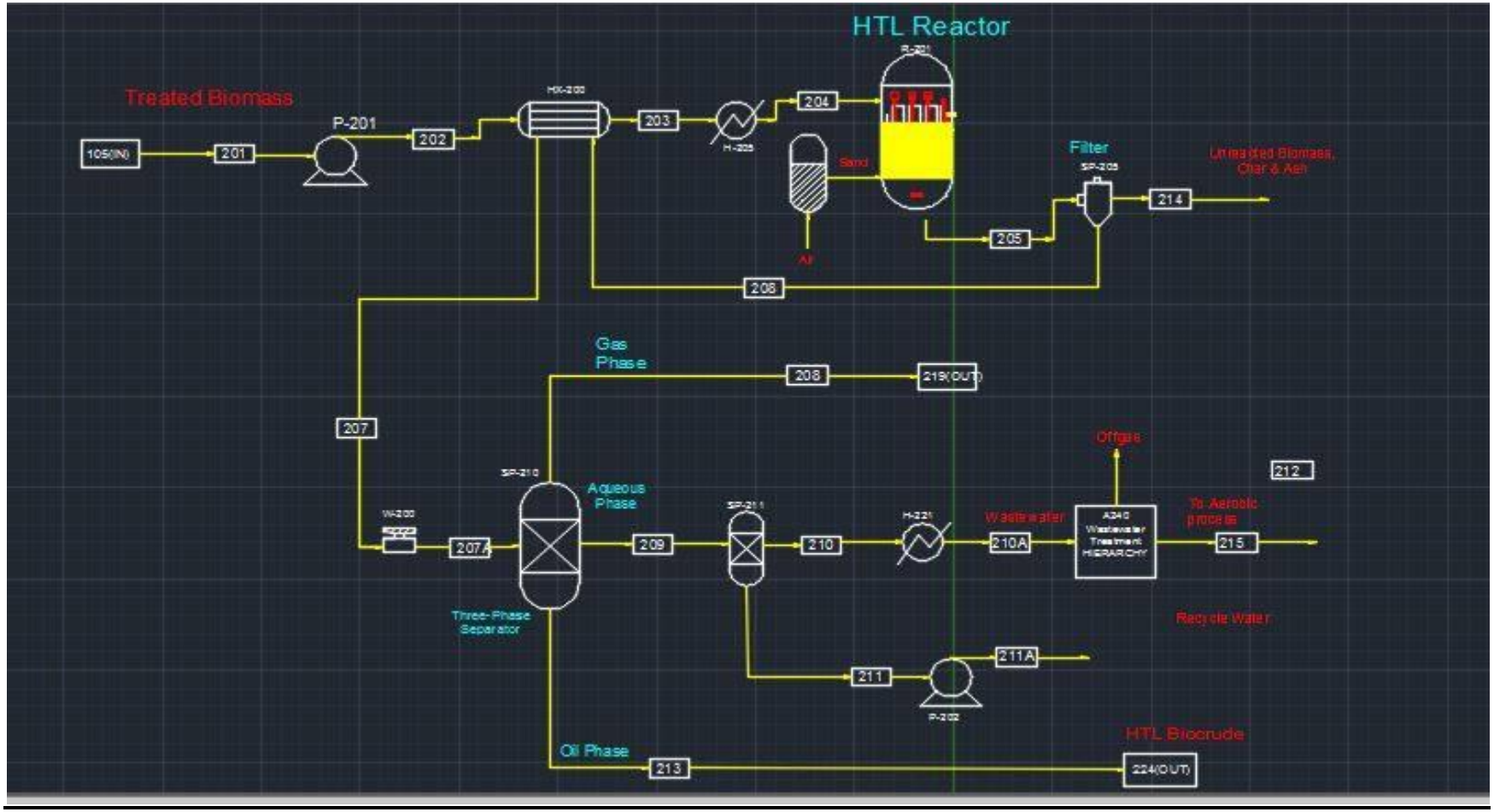
Mass balance for solids

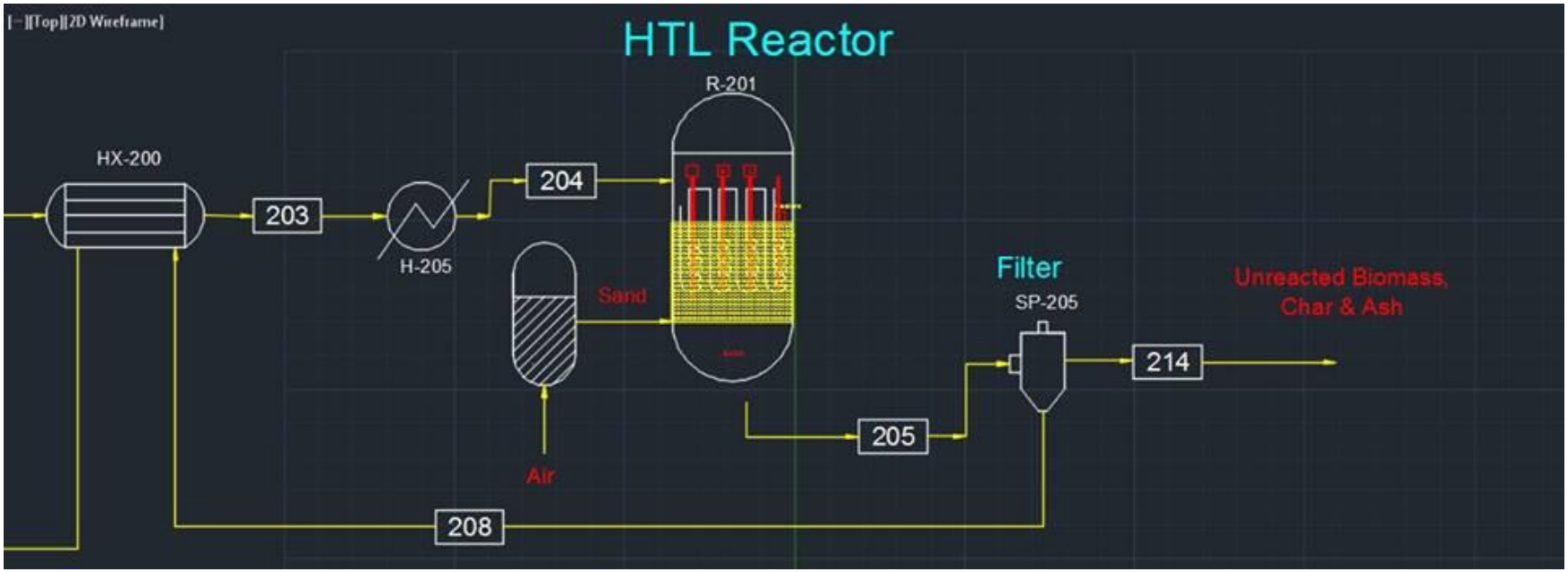
$$\dot{m}_6 = \frac{100kg}{s} \times \frac{5.7}{100} = 5.7\frac{kg}{s}$$

Input	Output				
Slurry (food waste)	Recycle water	Non-condensable gas	Bio-crude	Aqueous phase	Solids
100 kg/s	6.8 kg/s	17.5 kg/s	34.6 kg/s	35.4 kg/s	5.7 kg/s

Mass input = Mass output

Process flow diagram (PFD)




[-][Top][2D Wireframe]
HTL Reactor
R-201
HX-200
203
H-205
204
Sand
Air
Filter
SP-205
Unreacted Biomass,
Char & Ash
214
205
208