# Liquid fuels and chemicals sector

## Existing ammonia plant characterisation

**Existing capacity of ammonia plant**

Sasol has two ammonia plants, with a combined capacity of 660 ktpa, located at Sasolburg (330 ktpa) and Secunda (330 ktpa) (Sasol, 2009, 2014). As of 2017, Sasol’s ammonia production was 313,043 tonnes (Sasol, 2017a). In April 2020, Sasol suspended production at Sasol’s Sasolburg ammonia plant, with Sasol Synfuels running at 75% capacity for the remainder of the year (Brelsford, 2020).

**Energy inputs in PJ per PJ ammonia output (natural gas, electricity and other if any)**

|  |  |  |
| --- | --- | --- |
| Feedstock | Process | Net primary energy consumption [GJ/t NH3 (LHV)] |
| Natural gas | Steam reforming | 28 |
| Heavy hydrocarbon | Partial oxidation | 38 |
| Coal | Partial oxidation | 45 |

Source: (JRC, 2007)

## New ammonia plant characterisation

**Investment cost in USD/ton/year ammonia and USD/ton/PJ/year (learning?)**

<https://ammoniaindustry.com/the-capital-intensity-of-small-scale-ammonia-plants/>

Greenfield: USD 1,300 – 2,000 per tonne of ammonia annual capacity

Brownfield: USD 900 – 1,000 per tonne of ammonia annual capacity

The capital cost for a natural gas ammonia plant production facility is USD 740 million for 2,200 t/day facility (2007 USD) (Bartels and Pate, 2008). The capital cost for a plant that uses pure hydrogen as a feedstock and extracts nitrogen from the air is USD 430 million for 2,200 t/day ammonia production (Bartels and Pate, 2008).

|  |  |
| --- | --- |
|  | NH3 base case [Euro] |
| Total plant cost (TPC) |  |
| Total plant cost | 546,600,000 |
| Contingencies | 109,320,000 |
| **Sub-total** | **655,920,000** |
| Spare parts | 3,279,600 |
| Start-up and commissioning cost |  |
| Start-up CAPEX | 13,118,400 |
| Additional fuel cost | 1,725,457 |
| O&M | 2,566,044 |
| Catalyst and chemicals | 591,940 |
| Owners cost | 45,914,400 |
| Interest during construction | 125,912,501 |
| Working capital | 109,589 |
| **Sub-total** | **193,217,931** |
| **Total capital requirements** | **849,137,931** |

Source: (IEA, 2017)

**Estimate of running costs in USD/ton/year**

This is largely dependent on the price of natural gas (if used as an input) or alternative inputs. (Bartels and Pate, 2008) estimate that O&M costs of 4% of overnight capital costs.

**Estimate of efficiency of PJ per PJ ammonia output (hydrogen, electricity and other)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Units | Gas turbine required | Electricity from H2 Plant |
| Energy requirement | kWh/tonne NH3 | 390 | 390 |
| Electricity production LHV efficiency | % | 35 | 100 |
| Equivalent H2 requirement | Kg/tonne NH3 | 33.44 | 11.70 |
| Total H2 requirement per tonne NH3 | Per tonne NH3 | 211.01 | 189.27 |
| Conversion efficiency | % | 84.2 | 93.8 |
| LHV efficiency | % | 73.4 | 81.8 |

Source: (Bartels and Pate, 2008)

## Other process emissions in the chemicals sector

**Quantify abatement possible**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mitigation action | Description | Process emissions abatement potential [%] | Applicability [%] | CAPEX per site [2010 Million ZAR] | OPEX per site [2010 Million ZAR] | Abatement cost [2010 ZAR/tCO2eq] | Site production capacity [Mt/yr] | Lifetime [Year] | Uptake [%] |
| Replace coal-fired partial oxidation processes with natural gas-fired steam reforming production (ammonia): | Natural gas-power steam reforming process uses 28 GJ/t ammonia of energy and 1.6 CO2 t/t ammonia compared to 42 GJ/t ammonia and 3.8 CO2t/t ammonia for coal-powered partial oxidation | 42% | 100% | 240 | 12 |  | 0.4 | 25 | 2020/2030/2050: 50% |
| CCS (for new ammonia plants): | Capture of flue gases | 90% | 100% |  |  | 585 |  | 25 | 100% by 2030 |
| N2O abatement for new production plants (nitric acid): | N2O emissions removal efficiency of 98-99%  can be achieved | 90% | 100% | 3.2 | 0.2 |  | 0.3 | 25 | 100% by 2020 |

Source: MPA, 2014

## Petroleum refining: emissions abatement

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Emissions abatement potential [%] | Applicability [%] | Fuel/energy saving potential [%] | Applicability [%] | Electricity saving potential [%] | Applicability [%] | Uptake [%] |
| Improve steam generating boiler efficiency |  |  | 5% | 38% |  |  | 100% by 2020 |
| Improve process heater efficiency |  |  | 5% | 18% |  |  | 100% by 2020 |
| Waste heat recovery and utilisation |  |  | 5% | 100% |  |  | 50% by 2020, 100% by 2030 |
| Minimise flaring and utilise flare gas as fuel | 75% | 100% |  |  |  |  | 100% b6 2020 |
| Efficient energy production (CCGT and CHP) |  |  |  |  | 60% | 100% | 50% by 2030 |
| Waste heat boiler and expander applied to flue gas from the FCC regenerator |  |  | 15% | 20% |  |  | 100% by 2020 |
| CCS - Existing refineries | 70% | 100% | -40% | 100% | -10% | 100% | 50% by 2030 |
| EMMS |  |  | 2% | 100% | 2% | 100% | 100% by 2030 |
| Improved process control |  |  | 2% | 100% | 2% | 100% | 100% by 2030 |
| Improved heat exchanger efficiencies |  |  | 10% | 40% |  |  | 50% by 2020 |
| Improved electric motor system controls and VSDs |  |  |  |  | 10% | 60% | 50% by 2020, 100% by 2030 |
| Energy efficient utility systems |  |  |  |  | 10% | 40% | 50% by 2020, 100% by 2030 |

Source: MPA, 2014