Arthur D Little

Summary

An extensive study commissioned by SQM Chemicals to Arthur D.Little Benelux sa/nv in 2014 suggests that the GHG (Greenhouse Gases – generally considered to be the main contributors to global warming) footprint of SQM potassium nitrate obtained starting from caliche ore mines in Chile delivered to a main port in Europe (Rotterdam) and the US (Houston) is lower compared to synthetic potassium nitrate produced in a Middle East location, starting from ammonia ex natural gas.

The use of potassium nitrate produced by SQM ex caliche rather than its synthetic ammonia derived counterpart contributes thereby to overall sustainability.
Depending on the assumptions retained and assuming potassium nitrate volumes of 600 kt, it corresponds to avoiding GHG emissions comprised between 95 kt and 350 kt CO2e per year – a quantity equivalent to taking out of the road up to 155,000 average cars.

According to the study, the GHG footprint of potassium nitrate ex caliche is also substantially lower than an equivalent – from a functional plant nutrient value perspective – blend of nitrogen and potassium containing fertilizers based on ammonium nitrate and sulfate of potash

Introduction

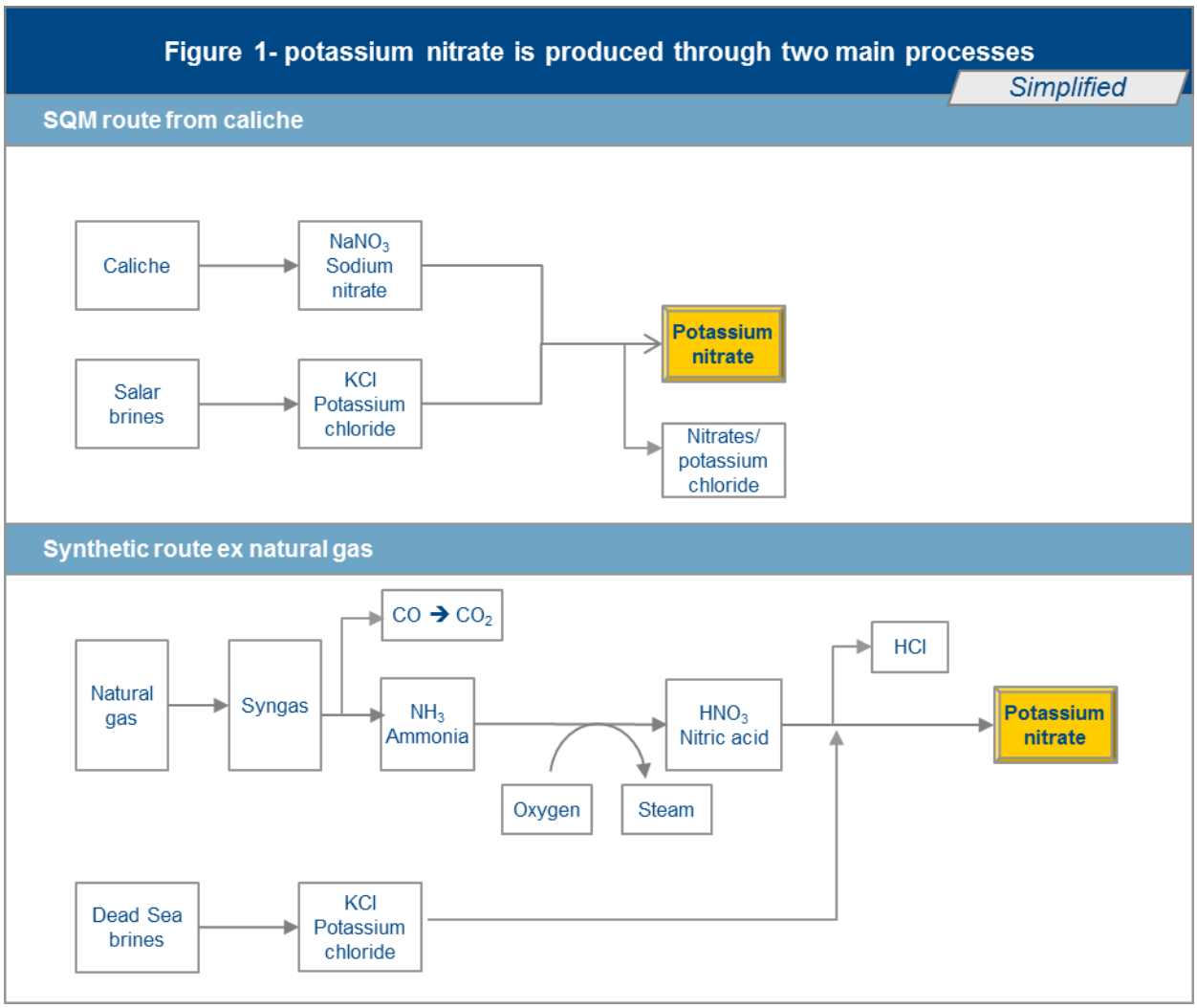
Potassium nitrate is an important source of nitrogen and potassium – two macronutrients essential to vegetable life. Due to the both its ready bioavailability as nitrogen source and water solubility, potassium nitrate is particularly suitable for use in modern horticulture in fertigation as well as for producing ready-to-use formulations of liquid and solid NPK fertilizers. It accounts for a significant share of the fertilizer mix applied in high value crops such as greenhouse-grown vegetables - its nearest proxy consisting of a blend of ammonium nitrate and sulfate of potash.

Potassium nitrate is produced through two main processes (see also Figure 1):

- From sodium nitrate obtained from the mining and processing of caliche ore of the Atacama desert in Northern Chile reacted with potassium chloride coming from salars located in the same region – the process applied by SQM
- Reaction of synthetic nitric acid – obtained through catalytic oxidation of ammonia – itself stemming from natural gas – with potash – the process applied by the other producers

In 2014 SQM has commissioned to Arthur D.Little Benelux sa/nv a study to:

- Assess the GHG footprint of potassium nitrate obtained starting from caliche ore mines in Chile delivered to a main port in Europe (Rotterdam) and the US (Houston)
- Compare it with the GHG footprint of:
    - Potassium nitrate produced from synthetic ammonia in selected Middle East locations
    - An equivalent – from a functional plant nutrient value perspective - blend of nitrogen and potassium containing fertilizers – namely AN (ammonium nitrate) + SOP (sulfate of potash)



Methodology

The GHG footprint has been estimated on a "cradle-to-gate" basis following the EU Commission recommendation of April 9, 2013, fully in line with ISO 14000 standards. Simapro 8 has been used as the modeling software, the environmental footprint being calculated applying the Impact 2002+ methodology.

The calculation includes the emissions associated with delivery to a main port in North America and West Europe taking into account:

- All the inputs serving in the production process
- Electricity and other energy sources
- Transportation of the various inputs to the production unit as well as the shipping of the final salt from the production unit to the main port of delivery

when required an allocation based on mass balances as recommended by international guidelines being applied between the different co-products stemming from the various processes.

The specific inputs for the caliche based process covering the calendar year 2013 have been provided by SQM, while for synthetic routes starting from ammonia data were derived from various publicly available data

bases and publications – different scenarios being considered in terms of plant location and technology efficiency, including Best-Available Technology (BAT).

Specific GHG emission factors emission factors for fuel combustion, electricity and transportation were derived from EcoInvent3, ELCD and USLCI.

Key findings

As shown Figure 2 the GHG footprint of potassium nitrate produced by SQM starting from caliche ores is lower compared to its counterpart obtained from natural gas in a Middle East location.

The emissions of SQM potassium nitrate supplied to a main European port stand at 766 gr CO2e/kg while – depending on the nitrogen oxides abatement efficiency assumed – those associated with material produced ex natural gas in the Middle East are estimated between 922 and 2230 gr CO2e/kg.

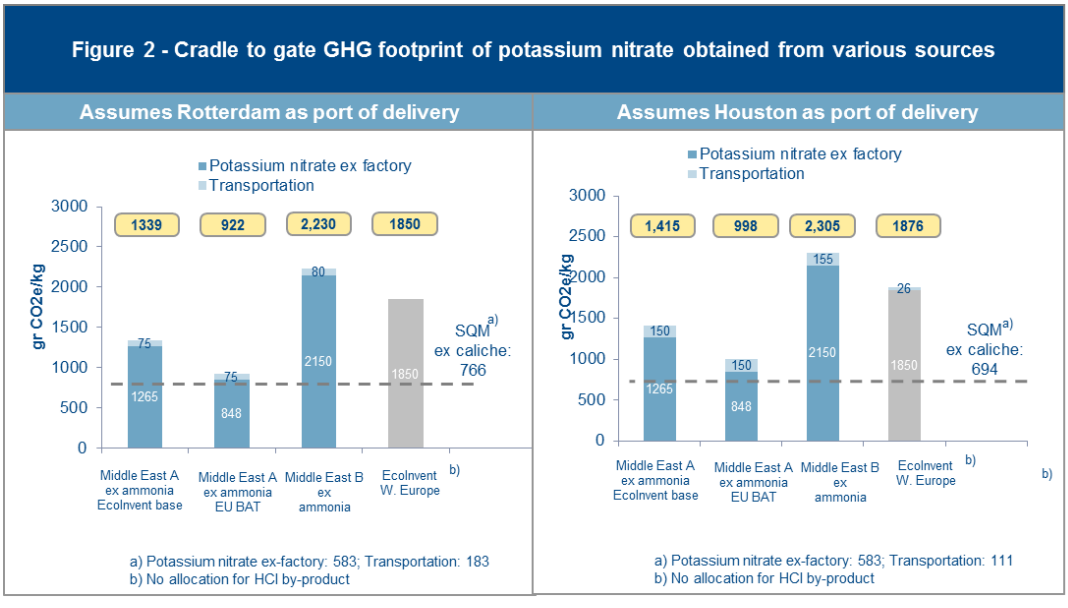
The higher footprint noted for synthetic potassium nitrate reflects:

- Use of fossil energy sources – mainly natural gas as feedstock and fuel in ammonia synthesis
- Emissions of nitrogen oxides associated with the production of nitric acid – these gases having a GHG power almost three hundred times higher compared to carbon dioxide

the release of carbon dioxide in the atmosphere as co-product as well as the generation of calcium chloride having to be disposed as waste given absence of local suitable outlets explaining the high GHG estimated for some locations.

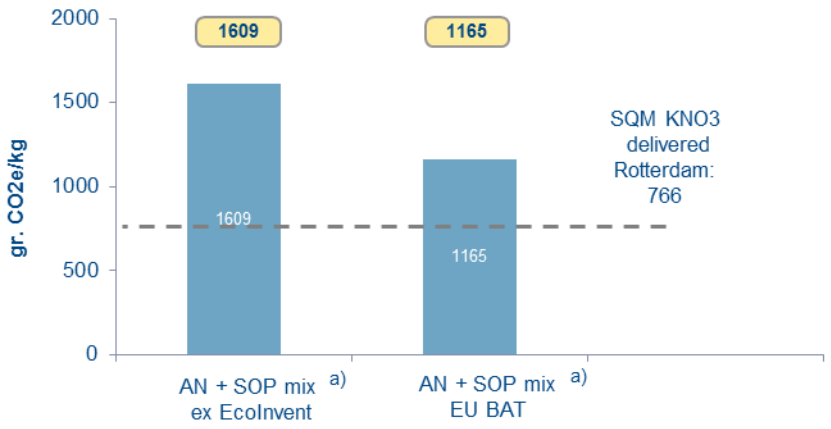
Transportation from the potassium nitrate production site to the port of destination contributes little to GHG emissions compared to the production of potassium nitrate, even when this salt is shipped from Chile to Europe – over 7300 nautical miles away – this impacting for 183 g CO2 e/kg.

Figure 2 - Cradle to gate GHG footprint of potassium nitrate obtained from various sources



As illustrated in Figure 3 the GHG footprint of potassium nitrate ex caliche ore is also substantially lower than an equivalent – from a functional plant nutrient value perspective – blend of ammonium nitrate and sulfate of potash – even when ammonium nitrate is assumed to be produced based on EU 'best-available-technology'.

Figure 3 - The GHG footprint of KNO3 ex caliche delivered in Europe is lower compared to an equivalent quantity of AN+SOP



a) Expressed on a plant nutrient functional equivalence basis – namely 0.40 units of An and 0.92 units of SOP

Conclusions

Overall the use of potassium nitrate produced from caliche rather than its synthetic ammonia derived counterpart contributes to overall sustainability by reducing the GHG emissions.

Depending on the assumptions retained and taking into account an output of 600 kt of potassium nitrate, the use of potassium nitrate ex caliche rather than:

- Its synthetic counterpart allows to avoid GHG emissions comprised between 95 kt and 350 kt CO2e per year – a quantity equivalent to taking out of the road up to 155,000 average cars[a).]
- A functionally equivalent volume of an SOP+AN blend would avoid GHG emissions estimated between 240 and 500 kt CO2e per year – corresponding to up to 220,000 cars.

a) Assuming average mileage of 17,000 km/y and CO2e emissions of 132.4 g/km – corresponding to achievement for new models introduced in 2012