Research Findings

Calculation of Carbon Footprint of Potash at Dead Sea Works, Israel

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Overview of the DSW potash plant in Sdom. Photo by ICL.

Introduction

Dead Sea Works Ltd. (DSW), a potash manufacturer in Israel, together with international consulting firms[2], have conducted an in-depth analyses of Carbon Footprint (CFP) calculations throughout its products, production facilities and supply chain, focusing on the competitive advantages that low-carbon performance brings to the company. Based on these analyses, we outline the CFP of two types of potash (fine and compacted grades) and compare these results to available industry benchmarks. The calculations made cover all of the direct components related to the production of potash (extraction, production, delivery etc.) in the production of "fine" and "compact" potash grades, which are used for direct application and granulation, and direct application and blending, respectively.

Calculations of CFP

In order to accurately calculate the amount of carbon dioxide equivalent (CO_2e) used per tonne (or kg) of potash, DSW divided the production process of potash into four stages, and mapped all the greenhouse gas (GHG) emissions involved (Table 1). The process followed the standard method for assessing CFP as provided by the "Guide to PAS 2050; How to assess the carbon footprint of goods and services" (BSI, 2008). In 2011 it was modified according to Publicly Available Specification (PAS) 2050:2011 (BSI, 2011).

For each stage, we created a process map, and identified the activities that result in GHG emissions. The data was produced in 2008. For each emissions' source, we measured the annual activity figure (tonnes of raw material consumed or kWh of electricity used) using the following measurements (tCO_2e per tonne or kWh). The result was the tonne of CO_2e emitted by that source per year. The sum of the CO_2e emitted by all sources was then divided by the yearly production quantities, and the result was the tCO_2e per tonne of fine or compacted potash produced and delivered to the customer.

The work reported in this paper was undertaken by the GHG Center of Excellence at Israel Chemicals Ltd. (ICL), Tel Aviv, Israel.

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[2]SKM Enviros (UK) has supported ICL through this process, and potash was among a group of products that have undergone a certification process by the Carbon Trust.

Table 1. Schematic stages and main processes producing GHG in the production of potash fertilizer.

Stage	Main GHG producing processes
Carnallite production	• Pumping Dead Sea water to evaporation ponds • Managing, harvesting and delivery of carnallite to the plant
From carnallite to potash	• Using water for the process • Energy used during the process
Compaction	• Energy used during the process
Delivery[1]	• Energy used in the delivery process (trucks, railway, ship) till the product is at an "average" port (in our calculations this port is in the UK).

[1]Delivery is an extra stage, outside the boundaries of "Cradle-to-Gate" as described in the PAS 2050:2011 (BSI, 2011).

The term "product carbon footprint" refers to the greenhouse gas (GHG) emissions of a product across its life cycle, from raw materials through production (or service provision), distribution, consumer use and disposal/recycling. It includes the greenhouse gases carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), together with families of gases including hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and Sulphur hexafluoride (SF_6) (BSI, 2008; http://www.carbontrust.co.uk/solutions/CarbonFootprinting/what_is_a_carbon_footprint.htm).

"Cradle-to-Gate" describes the life cycle stages from the extraction or acquisition of raw materials to the point at which the product leaves the organization undertaking the assessment.

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Carnallite production

In the first production stage, water is pumped from the Dead Sea to the salt and carnallite ponds (about 10 km apart). The emissions are mostly related to electricity to power the pumps. The electricity is supplied by the Israeli grid, and the ICL Combined Heat & Power (CHP) plant at Sdom.

From carnallite to potash

This stage includes pumping of carnallite slurry for screening, thickening and filtering, flotation, crystallization, thickening, washing, drying and screening, warehouse and open storage (for delivery of "fine" grade); or feeding for compacting (for delivery of "compacted" grade).

Compaction

The following steps are conducted in the additional stage to produce compacted (granulated) potash: compacting, treating, screening and drying, warehouse and open storage.

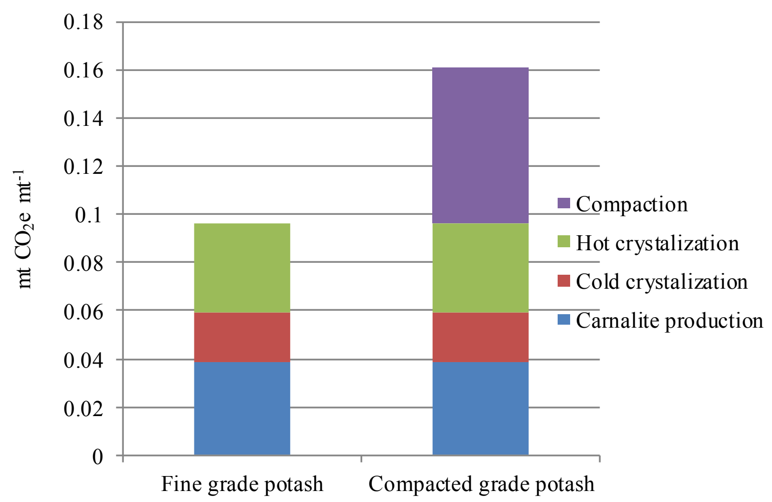

Fig. 1. CFP of fine and compacted (granulated) potash, by production stage (Cradle-to-Gate cycle).

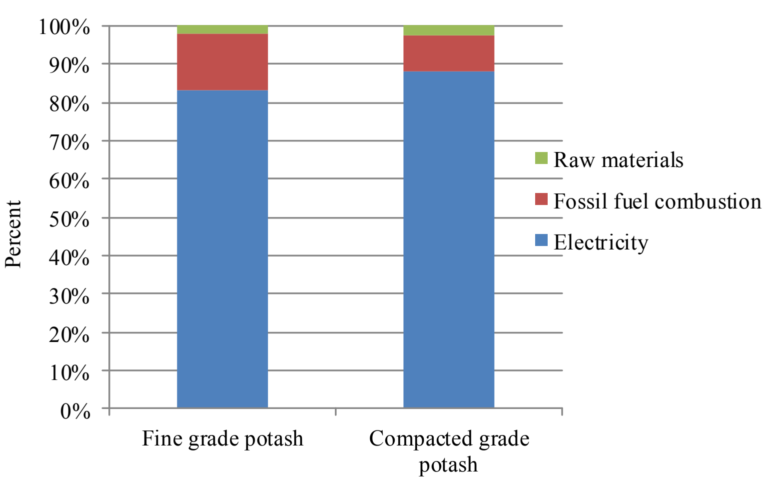

Fig. 2. Breakdown of the different emissions' sources share in the total Carbon Footprint of fine and compacted potash (Cradle-to-Gate).

Note: The emissions related to waste treatment and water consumption were negligible (under 0.1%) and hence not shown in Fig. 2. Raw materials used in the various stages (Table 1) are commonly used in the potash production process.

Delivery (extra stage, values calculated but not presented in this paper)

Delivery includes electric conveyor belt, and transport by truck, rail and ship. Each stage has its own factor of emissions per tonne kilometer, allowing calculation of the total CFP of the delivery (tCO_2/t product). This stage is not a mandatory addition to the product CFP, according to the new version of PAS 2050 (issued in 2011), which recommends a "Cradle-to-Gate" approach.

GHG emission factors for raw materials used in the different processes were provided by ICL suppliers or evaluated from published data (such as life cycle analysis databases) and added to the total CFP.

The breakdown of the CFP by production stage is shown in Fig. 1.

Results and conclusions

The calculated CFP for DSW Potash is 0.095 tCO_2e per tonne of fine potash and 0.161 tCO_2e per tonne of granulated potash, from cradle to the plant's gate[3].

Granulated potash has higher emissions due to the additional compaction stage, and slightly more carbon intensive transportation. The main source of emissions within the material extraction and manufacturing stages is the consumption of electricity. After 2008 (the year from which the data was used), the officially published GHG emission factor of the national electrical company in Israel has dropped by over 20%, due to a major transition to natural gas dependency. DSW has also started using natural gas in its Sdom CHP plant and other facilities. Therefore, the CFP

[3] ICL has also calculated the CFP value at the port of the average customer, which also takes into account the delivery of the product. The results were 0.159 tCO_2e per tonne of fine potash and 0.243 tCO_2e per tonne of granulated potash. However, these figures are highly dependent on the actual location of the specific customer, and thus are not recommended by the new PAS 2050 standard, issued in 2011.

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of potash produced by DSW is now expected to be lower. The ICL GHG Centre of Excellence has estimated that this transition could save about 20% of the energy-related emissions for potash, thus potentially reducing the CFP to about 0.076 tCO_2e per tonne of fine potash and 0.130 tCO_2e per tonne of granulated potash. A more precise re-calculation of the CFP is planned in 2012.

Kongshaug (1998) and later Jensenn and Kongshaug (2003) calculated the CFP of N, P and K fertilizer products. For these, they calculated a European average figure of 0.2 tCO_2e per tonne of potash, up to the manufacturer's gate. This figure is more than twice as high as the figure calculated for the ICL fine potash up to the same life cycle stage (0.095 tCO_2 per tonne). A possible explanation for this is the energy-efficient Carnallite extraction process employed at DSW. The factory uses the strong solar energy in the Dead Sea area by concentrating the brine in evaporation ponds. Moreover, potash has a much lower CFP than all forms of nitrogen-based fertilizers, due to the very energy intense process of nitrogen fixation (1.97 tCO_2e per tonne of nitrogen in modern ammonia plants; Kongshaug, 1998).

In conclusion, CFP calculation is an essential tool for product comparison, with regards to sustainability factors. Moreover, we assume that in the near future, industries will have to submit CFP calculations to the authorities (e.g. Poidevin, 2011). With agriculture accounting for approximately 30% of global GHG, the efficient use of energy is essential. The effective usage of solar energy at DSW significantly reduces the CFP of the company's potash.

Dredger used to harvest the carnalite from the pond's bed. Photo by ICL.

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The paper "Calculation of Carbon Footprint of Potash at Dead Sea Works" appears also at:

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