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B R I E F I N G

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Potash Fertilizer Production

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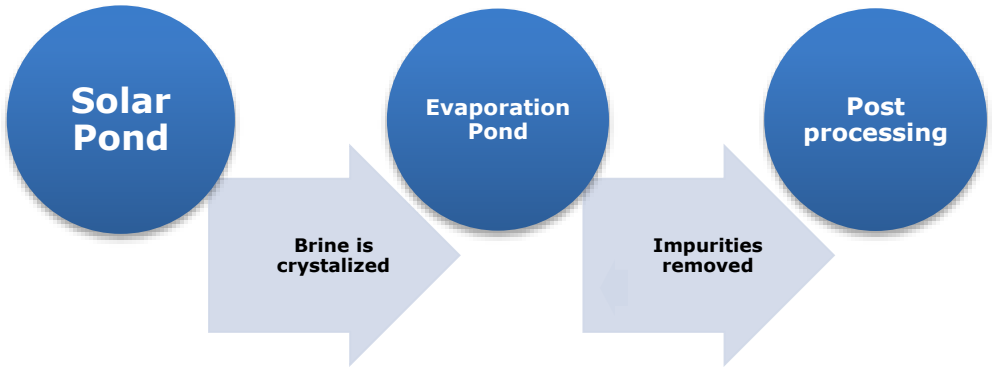
Introduction

Most agricultural fertilizers contain three basic plant nutrients -- nitrogen, phosphorus, and potassium -- as well as small amounts of certain "micronutrients" such as zinc and other metals necessary for plant growth. Potassium (K), commonly known as potash, is essential for maintaining plant quality and health, helping plants produce protein, and reducing wilt. Potash reduces winter kill in alfalfa, increases corn yields and soybean oil content, improves wheat milling and baking qualities, and is critical for the production of high-carbohydrate crops such as potatoes, sugar beets, and grapes. Although potassium occurs naturally in many soils, much of it is inaccessible to plants because it is highly soluble. Hence, potassium tends to leach quickly through soils and away from plant root zones. Therefore, most agricultural producers include potash as a component of annual fertilizer applications. This briefing paper describes the processes used by manufacturers to convert potash deposits into crop-accessible fertilizers.

Production from Surface Water Brine

Potassium can be collected from surface water brine deposits (e.g., the Dead Sea or Great Salt Lake regions[1]) by evaporating excess water to form potassium chloride which is subsequently purified and processed (International Fertilizer Development Center). Although each surface water brine deposit site is unique and requires specific processing approaches, the general approach involves three steps that moves brine across a series of ponds (Figure 1).

Figure 1: Potassium Processing using the Sequential Pond Mechanism



Objective Analysis For Informed Decision Making

[1] Other potassium surface deposits include: Salar de Atacama, Qarhan Lake, and Qaidam Basin, China; Cerro Prieto, Mexico; Bonneville Salt Flats, UT; and Searles Lake, CA.

First, surface brine is crystalized in solar ponds using evaporation to form potash salts and to remove halite. The process yields potash salts. Second, the remaining salt solution is partially evaporated in adjacent ponds to separate potassium chloride from remaining impurities such as carnallite, which are often captured and used in other production processes. Third, remaining potash crystals are collected for further processing.

Production from Mined Potash Deposits

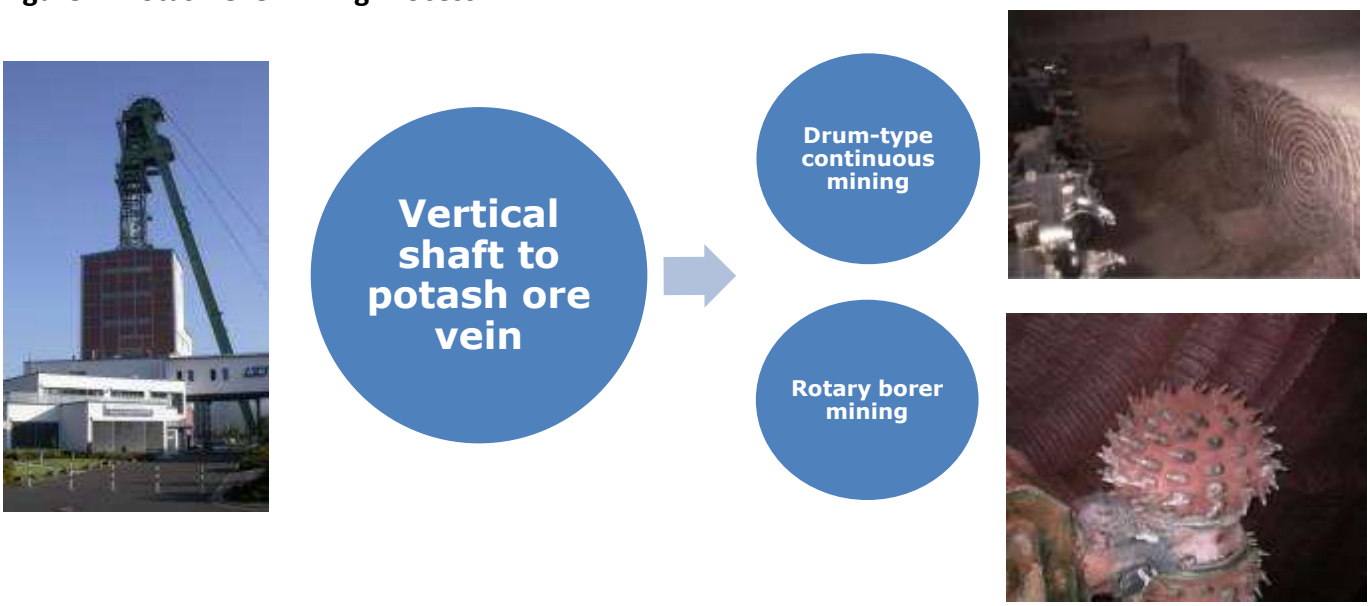
Potash is more commonly produced by shaft mining ore deposits, which are typically found approximately 3,000 feet underground (International Plant Nutrition Institute).[2] Potash ore deposits are known to exist in at least 21 countries, but production occurs in only 12 for a variety of reasons. Specifically, differences in geologic formations, infrastructure, mine safety, and ore purity cause production to occur in countries with cost advantages.

In 2011, five countries (Canada, Russia, Belarus, China, and Germany) accounted for nearly 80 percent of the world's total production. Consequently, most countries rely on imports to meet domestic demand as 80 percent of the world potash production is exported.

The mining process involves drilling vertical shafts to reach potash ore deposits and then using appropriate ore extraction methods based on the geologic structure of the deposits. If ore veins are horizontal and uniform, a drum-type continuous mining machine is used to mine the deposits. Less uniform ore veins are mined with rotary borers and explosives that carve out large underground chambers. Figure 2 presents a characterization of these processes.

After ore is removed from a vein, it is transported to a collection location by shuttle cars or conveyor belts and then hoisted to the surface for processing. At the surface, ore is crushed to less than 2 millimeters in size, cleaned, and potash material is separated from other clay minerals. The potash material is then rinsed, and a brine is created. This brine is agitated with a salt solution to remove impurities. Potassium minerals naturally rise to the surface of the brine, where they are collected (Figure 3). The mineral brine is pumped into shallow ponds and rinsed with additional brine water. The liquid is then allowed to evaporate in ponds and the remaining product is heated in boiling water. As the solution cools, potassium chloride crystals form and are harvested, heated, compressed, crushed, and processed into granular fertilizer products.

Figure 2: Potash Ore Mining Process



[2] Solution mining is used when potash deposits are deep and irregular or if a mine becomes flooded. This process is less common and uses submersion pumps and slurries to extract deposits.

Figure 3: Skimming and Potassium Chloride Crystallization Processes

(a) Skimming of potassium minerals

(b) Potassium chloride crystallization

Potash Fertilizer

Potassium chloride (MOP or KCl) contains 40–60 percent potash. Compounds can be produced in different colors and sizes and its granular form can be blended with other minerals and fertilizers to produce composite fertilizers such as urea and potassium chloride (Figure 4). Potassium sulfate (SOP) contains 50 percent potash and is used on plants that are particularly sensitive to chlorine such as potatoes, fruits, and tobacco. SOP is produced by blending sulfuric acid and potassium chloride and then converted into granules. Potash granules can be applied directly to fields or dissolved in water and applied through irrigation systems.

Summary

Potash fertilizers are produced from surface salt water brine and potash ore deposits. Because surface deposits are quite limited, most potash is produced with ore obtained using shaft mining techniques. Potash ore is crushed, brined, heated, and evaporated to obtain potassium chloride crystals. These crystals are then processed into granular forms of potassium fertilizer and often blended with nitrogen and phosphate fertilizers.

References:

International Fertilizer Development Center. Fertilizer Manual. Dordrecht, Netherlands 1998. Pages 140-150.

International Plant Nutrition Institute. Potassium Fertilizer Production and Technology. Norcross, GA.

The Fertilizer Institute. Fertilizer 101. Washington D.C. 2004

Figure 4: Alternative Forms of Potash Fertilizers

(c) Iron oxide coloration in KCl

(b) Soluble grade

(c) Iron oxide coloration in KCl

(d) Potassium sulfate

(e) Urea and potassium chloride