

Production and Use of Potassium

Potassium (K) is essential to all forms of plant and animal life. It is a chemically active metal. Because of its highly active characteristics, K is never found in its pure elemental state in nature. It is always combined with one or more other elements.

Potassium is found widely distributed throughout the Earth's crust. It is the seventh most abundant element in the world. It is not only found in every living plant and animal, but is also found in rocks, minerals, soils, lakes, rivers and oceans.

Agricultural soils may contain from 2 to 30 tons/A of total K in the upper six inches. However, most of this is chemically bound in insoluble mineral forms and is unavailable, or only slowly available to plants.

Many soils have been depleted of available and slowly available K by decades or even centuries of continuous farming with crop removal exceeding inputs. For example, in any given year, the major field crops grown in the U.S. and Canada, including hay and forage, often remove many times more K than is applied.

Potash refers to a variety of K-bearing minerals that are used for fertilizer. It includes potassium chloride [KCl, or muriate of potash (MOP)], potassium sulfate [K_2SO_4 , or sulfate of potash (SOP)], potassium-magnesium sulfate ($K_2SO_4 \cdot MgSO_4$, or sulfate of potash magnesium), potassium nitrate (KNO_3 , or saltpeter), and mixed sodium-potassium nitrate ($NaNO_3 + KNO_3$, or Chilean saltpeter).

The term "potash" comes from "pot ashes" which, in Colonial days in North America, were the primary source of K for fertilizers and for soap, glass, gunpowder, and

other industrial uses.

Potash is sold on the basis of its oxide or K_2O equivalent content. For example, chemically pure KCl contains 52.44 percent K or 63.17 percent K_2O equivalent. Converting from K to K_2O or vice versa is a simple calculation: percent K_2O = percent K x 1.2; percent K = percent K_2O x 0.83.

Potash Fertilizer Materials

In North America, MOP accounts for approximately 95 percent of all potash fertilizers. Potassium sulfate and $K_2SO_4 \cdot MgSO_4$ are also widely used sources, but account for less than 5 percent of the

total. Other forms of potash are used only to a very limited extent. The K content of the most common potash fertilizers is shown in **Table 1**.

Other Potash Materials

Some industrial wastes offer a source of potash. Tobacco stems, wool waste, sugar beet factory waste, flue-dust, and similar wastes from many industries can have limited use.

Mixed Fertilizers

While nearly all the potash fertilizer used comes in one of the forms described above, a considerable proportion of it is applied to the

Potash fertilizers are mined and refined from underground ore deposits, salt lakes and brines. North America, the Former Soviet Union, and Europe account for almost 90 percent of world output. Known potash reserves are estimated to be equivalent to 9 billion tons K_2O .

TABLE 1. Composition of important potash fertilizers.

Form of potash	%	
	K_2O	K
KCl	60-62.5	49.8-51.9
K_2SO_4	50-52	41.5-43.2
$K_2SO_4 \cdot MgSO_4$	22	18.3
KNO_3	44	36.5



Photo courtesy of Potash Corporation of Saskatchewan Inc.

Giant mining machines cut into the potash ore in underground bedded deposits.

soil as part of a fertilizer which contains one or more other nutrients in addition to potash.

Thus in a 5-20-20 fertilizer, there is 5 percent nitrogen (N), 20 percent P_2O_5 , and 20 percent K_2O by weight.

The analyses are always stated in the same order. Blended fertilizers, a physical mixture of such materials as KCl and diammonium phosphate, are widely used. Fluid fertilizers contain relatively small amounts of K in clear solutions but relatively high amounts in suspensions.

Mining of Potash

Most potash fertilizers are mined from **underground bedded deposits**.

In Saskatchewan, Canada, most deposits are more than 3,000 feet below the surface while in New Brunswick the deposits are approximately 2,500 feet below the surface. The Canadian deposits are, however, of high grade, thick, and relatively easy to mine once a shaft is sunk to the level of the bed. In the area of Carlsbad, New Mexico, deposits are located between 700 and 1,800 feet underground.

Solution mining is another method of extracting potash from underground deposits. In this method, water is injected into the deposit through a well to dissolve the salts, and a solution containing the K and sodium (Na) chlorides is withdrawn through another

nearby well. This method has advantages when the deposit is irregular in shape or when the depth is too great for conventional mining.

A third method for mining potash is the **evaporation of water from salt lakes and subsurface brines**. This technique is used in the U.S. at the Great Salt Lake and Bonneville Salt Flats in Utah, in Searles Lake in California, and in Israel and Jordan at the Dead Sea. The water that is already near the saturation point in K, Na and Mg salts is further evaporated in shallow ponds, and the different salts are separated.

TABLE 2. World potash production (1997) and reserves by country.

Country	Mine production	Reserve base
	million tons K_2O	
Canada	9.3	10,700
Russia	3.1	2,400
Belarus	2.9	1,100
Germany	3.5	960
Brazil	0.3	660
Israel	1.4	640
Jordan	1.3	640
China	0.1	350
U.S.A.	1.6	260
Others	2.4	340
World total	25.9	18,050

Numbers may be rounded.

Source: U.S. Dept. of Interior, Bureau of Mines.

Potash Production and Consumption

Total world production increased from 15.9 million short tons K_2O in 1966 to 27.2 in 1976 and 31.7 in 1986. Production declined slightly to 25.3 million tons in 1996 and 25.9 million tons in 1997.

Seven countries produced 90 percent of the world's potash in 1997 (**Table 2**). Canada was the largest producer at 36 percent, followed by Germany (14 percent), Russia (12 percent), and Belarus (11 percent). U.S. production represented 6 percent of world output. Other producing countries include Brazil, Chile, China, France, Spain, Ukraine, and the United Kingdom, while very little or no potash is produced on the continents of Africa or Oceania.

Since the initiation of potash mining in Canada in 1962, production in North America has shifted from the U.S. to Canada. The high-grade ore reserves in Saskatchewan and New Brunswick are more economical to mine than the lower grade ore reserves remaining in the Carlsbad, New Mexico, basin.

Europe and the Former Soviet Union accounted for 30 percent of world potash consumption in 1997, followed by Asia at 25 percent, the U.S. at 25 percent, and Latin America at 15 percent.

In the fertilizer year ending June 30, 1997, 86 percent of the 10.8 million tons K_2O produced in North America came from Canada. Saskatchewan produced about 92 percent of Canada's potash. More than half of the Canadian production (60 percent) was shipped to the U.S.

The use of potash in the U.S. and Canada showed phenomenal growth in the three decades preceding 1980. In 1950, 1.5 million tons K_2O were used. By 1960, the figure was 2.2 million, and in 1970, 3.5 million. Consumption in the two countries peaked at more than 6 million tons in 1980 with more than 90 percent used in the U.S.

Since 1980, potash use in North America has fluctuated between 5 and 6 million tons K_2O . Much of this fluctuation is attributable to reduced prices for most crops in recent years, coupled with acreage control programs in the U.S.



Photo courtesy of IMC Global Inc.

Canada is the world's largest producer of potash. Large reserves remain there and in other countries.

Reserves and Resources

Potash reserves are those that can be mined economically under short-term marketing conditions. The reserve base includes demonstrated resources that are currently economic (reserves), marginally economic, and some that are currently subeconomic. Resources include proven, probable and inferred reserves.

In 1997, global reserves were estimated to be 9 billion tons K_2O , while the reserve base was estimated at about 18 billion tons (**Table 2**). Canada and Russia have over 70 percent of the total reserve base.

In addition to those listed in **Table 2**, other producing countries have small reserves (Chile, France, Spain, Ukraine, and the United Kingdom) and undeveloped deposits exist in a number of other countries.

Estimated world resources of potash total about 250 billion tons. Canada's potash resources are estimated at about 48 billion tons, and total U.S. resources are estimated at about 6 billion tons. Most of U.S. resources occur as bedded deposits between 6,000 and 10,000 feet below the surface in Montana and North Dakota. Some 2 billion tons occur 4,000 feet below surface in Utah and at least 25 million tons about 7,000 feet deep in Michigan. At these depths, solution mining is the only recovery method that is feasible. At present production levels, North America has sufficient potash resources for several thousand years. **BC**