Salt

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BRIEF HISTORICAL FACTS

The word "salt" comes from the Greek word *halos* and is also commonly referred to as sodium chloride (NaCl).

Human history was shaped by the need for salt. Wars were fought over the possession of salt deposits. Salt bought slaves and at times was traded at twice the value of gold. Armies and civilians required salt to maintain health, preserve meat and tan leather. Salt became one of the world's first commodities.

Salt is such a common part of our everyday lives that we rarely think of it as a natural resource that must be discovered, boiled/evaporated or mined, processed, marketed and consumed. Each human being contains about four ounces of salt and, unless we get enough of it, our muscles won't contract, our blood won't circulate, our food won't digest and our hearts won't beat. The same is true for livestock; therefore, salt is important in diets.

The salt markets in developed regions such as North America and Western Europe are mature and expanding at a rate a little below the average growth of the world economy. The main consuming regions are North America, Asia and the Middle East, and Western Europe. World salt consumption is on the rise, mainly in response to increasing demand in the countries of Southeast Asia and other developing nations.

Based on reported and estimated information from the U.S. Geological Survey (USGS), the outlook for salt is favourable with world salt production for 2004 projected to increase to 215 Mt, less than the 217 Mt produced in 2001. In 2002, total estimated world production declined to 210 Mt. Salt consumption for chemical uses, particularly chlor-alkali manufacture, can fluctuate depending on the demand for chlorine and co-product sodium hydroxide. Demand for chlorinated bleaching agents has declined, while the demand for oxygenated bleaching compounds has increased. Most of the other uses of salt (e.g., food processing, water treatment and industrial uses) tend to follow population trends. Although de-icing salt is not significantly affected by economic events, the quantity of salt consumed for road de-icing each year is directly related to winter weather conditions.

CANADIAN SUMMARY

Canada, like many countries, extracts, processes, consumes, exports and imports salt. Canada has a vast territory with many known deposits and some that are yet to be discovered. Only a few areas are exploited by a small group of companies that are large players in the industry. Most of the use for salt is for de-icing, chemicals and domestic (e.g., table, food-grade, livestock feed) uses.

Major Canadian salt deposits are found in Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan and Alberta. Many salt deposits have been discovered while exploring for oil and gas and potash. In Prince Edward Island, a rock salt deposit of undetermined size was encountered at a depth of over 4200 m under Hillsborough Bay on the southern side of the island. Brine springs, usually indicative of salt deposits, have been found in two of the other provinces, namely Newfoundland and Labrador and British Columbia. Production in most of these provinces is by two main methods of extraction (i.e., underground room-and-pillar mining and brining).

Canada's high level of consumption, which at one time was estimated at over 360 kg of salt per person per year (consumption statistics were available until 1987), is due to severe winter conditions in many parts of the country and the use of road salt to improve winter driving conditions.

Canada is the fifth largest producer of salt (Table 3). Preliminary data indicate that Canadian salt shipments for 2003 were valued at $423.9 million (for 13.4 Mt shipped), a $4.3 million increase from 2002 (for 12.7 Mt shipped). This 2003 value reflects the cyclical production level from

year to year in response to winter conditions. Exports were valued at $125.3 million (for 4.2 Mt exported), a $28.7 million increase from 2002 (for 3.7 Mt exported), while imports were valued at $43.3 million (for almost 1.0 Mt imported), nearly an $8.0 million decrease from 2002 (for 1.4 Mt imported).

Although salt prices in Canada are not made available, other sources cited further below under 'Prices" provide an indication of prices by type and by packaging.

Environmentally, the use of road salt in Canada has been an issue. In April 2004, Environment Canada issued a Code of Practice for the Environmental Management of Road Salts. The Code applies to any organization that uses more than 500 t/y of road salts.

TRADE

Salt is a widespread, low-value, bulk commodity. It is relatively easy to extract and transportation represents a significant proportion of the total delivered price (one reason for imports into and exports from the United States and Canada for specific regions is the economic factor). As a consequence, international trade in salt is small relative to world production.

Preliminary data (Table 1) for 2003 show that Canada exported a total of 4.2 Mt (valued at $125.3 million), of which 99.8% was exported to the United States (valued at $124.6 million). This represented a 0.52-Mt increase from 2002, but was still less than the achieved 2001 export level of 4.6 Mt. The export of 3.7 Mt to the United States in 2002 was that country's largest source of imports, accounting for about 45% of its total imports (source: USGS).

Canada also imports salt. Preliminary data show that Canada imported 1.0 Mt in 2003 (valued at $43.3 million): 63.3% from the United States, 24.2% from Mexico, and 7.8% from Chile (Table 1). Data for 2002 show a different proportion of Canadian imports from these same countries: 46.6% from the United States, 31.7% from Mexico, and 17.9% from Chile, of total Canadian imports of 1.4 Mt. Data for 2001 were 68.8% from the United States, 17.8% from Mexico, and 7.9% from Chile, of total Canadian imports of 1.6 Mt. This decrease in 2003 imports over 2002 represented a 4.0% decrease from the United States, a 46.0% decrease from Mexico, and a 69.0% decrease from Chile.

On the other hand, Canada's 2002 imports of salt (0.6 Mt) from the United States represented close to 77% of the majority of total U.S. exports of salt (source: USGS).

CONSUMPTION

Of the millions of tonnes of dry salt produced annually in North America, a very small percentage finds its way to family dining tables either in commercially processed foods, in home preparations, or in the salt shaker.

On a per-capita basis, Canada is the largest consumer of salt in the world, and this is due mainly to its winter conditions. Most of the salt used as a de-icing agent is consumed in Ontario, Quebec and Atlantic Canada. The apparent domestic consumption (source: Canadian Salt Institute) is reflected as follows: chemical and de-icing uses account for between 90% and 95%, while the remainder is used for water conditioning, food processing, fisheries, and other industrial uses.

By far the biggest part of salt produced as brine and dry salt – approximately 70% – is used in the chemical industry. Directly or indirectly, salt plays a part in the manufacture of a seemingly endless list of chemicals and chemical products. For example, salt goes into the production of chlorine and into the manufacture of soda ash; in turn, these two products are used in the processing or manufacture of a wide variety of end products ranging from rayon, polyester and other synthetics to plastics for explosives, fertilizers, glass, and cosmetics.

Chemical raw materials represent 60% of world salt consumption, followed by table salt (20%) and road de-icing salt (10%); the remaining 10% is used in animal feed and water treatment. Consumption patterns differ in North America.

The United States provides consumption details and these could be used to reflect to a certain degree the North American consumption of Canadian salt. In 2002, the U.S. distribution of salt (source: USGS) by major end use was for chemicals (45%), ice control (31%), distributors (grocery and other wholesalers and retailers) (8%), general industrial (6%), agricultural (4%), food processing (3%), primary water treatment (2%), and other uses (less than 1%).

The U.S. Salt Institute's web site provides an explanation of the many uses of salt. It can be found at www.saltinstitute.org/16.html.

The industrial chemicals industry (source: Natural Resources Canada) consumes salt for the manufacture of chlor-alkali such as caustic soda (sodium hydroxide), chlorine, and sodium chlorate. Salt for caustic soda and chlorine plants (i.e., facilities) in Canada is obtained from on-site brining and natural brines; other plants use mined rock salt or imported solar or evaporated salt. Other industrial chemicals that require significant quantities of salt include

sodium bicarbonate, sodium chlorite, sodium hypochlorite, sodium carbonate (soda ash), and calcium chloride.

Most pulp and paper mills in Canada have carried out extensive process modifications and improvements in effluent treatment. Several have opted to reduce chlorine usage by installing other bleaching processes such as extended lignification, oxygen delignification, sodium chlorate bleaching, integrated chlorine dioxide with hydrochloric acid recycling, and ozone and hydrogen peroxide bleaching processes. Although seen as a step in the right direction by environmentalists, they would prefer that the industry adopt dioxin-free bleaches such as oxygen and hydrogen peroxide.

Sodium chloride, or salt, remains the primary de-icing agent. Different de-icers are used in accordance with site requirements. Calcium chloride is the second most used de-icer, being effective at temperatures ranging between -10 and -20°C; this chemical is usually mixed with salt at a 2-4% rate. Growing concerns over the environment and the corrosion of infrastructure, such as bridge decks and parking lots, have led to numerous experiments with de-icing salt substitutes.

PRODUCTION

Canada has an abundant resource of salt. The vast Canadian territory has three known major salt formations, all of great area and thickness, in economically strategic locations. The largest deposits are in western Canada, followed by Ontario and the Atlantic provinces.

In western Canada, the salt beds extend from the Northwest Territories down through Alberta, Saskatchewan and into Manitoba. This immense deposit, averaging 122 m (400 feet) in thickness and covering an area of approximately 390 000 km^2 (150 000 square miles), contains more than one million billion tonnes of salt.

In Ontario, salt is found along the shores of Lake Huron and Lake Erie. This deposit is part of the known Michigan Basin and is a saucer-shaped formation underlying part of Michigan, part of Ohio, and lakes Huron and Erie.

In the Atlantic provinces, large, thick deposits have been found underlying New Brunswick, Nova Scotia, part of Newfoundland and Labrador, and even the Gulf of St. Lawrence. These deposits occurred in various geologic eras and all of them are the remains of ancient inland seas. The shorelines of these ancient seas, which outline the edges of the salt beds, mark the occurrences of the oil, gas and coal deposits that have been found in such abundance in Canada.

Major salt deposits and dry salt production in North America can be viewed on the Internet at www.saltinstitute.org/images/map.pdf.

In 2002 (sources: USGS and Table 3), the top eight salt-producing nations that collectively accounted for 67.2% of total world output of 210 Mt, in descending order of quantity (Mt) produced, were the United States (40.3), China (32.8), Germany (15.7), India (14.5), Canada (12.3), Australia (9.9), Mexico (8.5), and France (7.0). In North America, some 52.6 Mt of salt were produced in 2002: 75.8% by the United States and 24.2% by Canada. The United States was the largest salt-producing nation, representing about 19.2% of total world output. Canada's share was 5.9% of world production, although the largest underground mine in North America is located in Goderich, Ontario.

Preliminary data for Canada for 2003 (Table 2) show shipments increasing to 13.4 Mt (85.3% being mined rock, 6.8% being fine vacuum, and 7.9% being brine and salt recovered in chemical operations). Table 2 shows that producers' shipments of mined rock salt have fluctuated since 1999, shipments of fine vacuum have increased since 1999, and shipments of brine and salt recovered in chemical operations have decreased since 1999.

Preliminary data for 2003 estimate that the Canadian salt industry produced 13.4 Mt of salt from major rock salt mines in Ontario, Quebec and New Brunswick and from vacuum pan refineries in Alberta, Saskatchewan, Ontario, New Brunswick and Nova Scotia. More than three-quarters of this production was rock salt, used primarily for highway de-icing.

Preliminary data also indicate that Canadian salt shipments for 2003 were valued at $423.9 million (for 13.4 Mt shipped), a $4.3 million increase from 2002 (for the 12.7 Mt shipped). This 2003 value reflects the cyclical production level from year to year in response to winter conditions.

Two major methods are used to obtain salt from Canada's age-old deposits: underground room-and- pillar mining and brining. Recovery as a co-product of potash mining is also practised. The most important Canadian producers are described below (Table 4).

In Nova Scotia, The Canadian Salt Company Limited operates an underground rock salt mine at Pugwash in Cumberland County. Most of the salt from this mine is used for snow and ice control. It also operates an evaporated salt plant where saturated brine is fed to a quadruple-effect vacuum pan; the brine solution is evaporated to produce high-quality salt crystals for use in the chemical and food industries.

Sifto Canada Inc.'s (a subsidiary of Compass Minerals Group Inc.) production process in eastern Canada is a brining operation at Amherst, Nova Scotia. Its vapour recompression process produces an unequalled salt purity in North America and its evaporated salt products are sold for table salt, fisheries, and water conditioning. This

particular operation is one of the newest, most modern evaporation plants on the continent.

In New Brunswick, Potash Corporation of Saskatchewan Inc. (New Brunswick Division) produces potash and salt at its underground mine near Sussex. It extracts salt and sells it mainly to the United States and eastern Canada. It also pumps brine back to the surface for re-use. This brine is produced from the clay slimes, and excess brine slurries from the processing plant are piped underground as backfill where rock salt has been extracted.

In Quebec, Seleine Mines Division (a subsidiary of The Canadian Salt Company Limited) is the only operating salt producer. Located on the Magdalen Islands in the Gulf of the St. Lawrence Seaway, it produces de-icing salt for markets in Quebec and the eastern United States.

Junex, an oil and gas exploration company, discovered a natural brine zone while drilling for gas in Bécancour. In 2001, Junex created Junex Solnat, which operates two natural brine well operations. Its natural brine is sold as a dust control agent (i.e., suppressor) and for ice removal products.

In Ontario, Sifto Canada Inc. operates an underground rock salt mine in Goderich Harbour on the shores of Lake Huron. It also operates an evaporating plant for brine production on the escarpment of the Maitland River. The products serve the home water softeners, packaged icemelts, agricultural salts, food processing, table salts, and industrial salts markets.

More commonly recognized under the leading consumer brand of Windsor, The Canadian Salt Company Limited is headquartered in Pointe-Claire, Quebec. It produces both rock salt from the Ojibway underground mine and vacuum salt from brine wells near Windsor. Salt products include de-icing road salt, and water softening, agricultural and chemical fine salt.

In Saskatchewan, Sifto Canada Inc. operates a brining operation near Unity for the production of fine vacuum pan salt, which is used for water softening, for agriculture and in food processing, as well as some de-icing salt for local use.

The Canadian Salt Company Limited at Belle-Plaine produces evaporated salt from by-product brines sourced from an adjacent potash solution mine operated by IMC Canada Ltd., a subsidiary of IMC Global Inc. Most of the production goes towards water softening; other uses are for agriculture, food processing, and ice control.

NSC Minerals Inc. is a leading supplier of industrial mineral products specializing in salt mineral crystals. It produces coarse and fine salt products from potash tailings. The head office for NSC Minerals Inc. is located in Saskatoon. It has two modern operating plants with a daily production capacity in excess of 6000 t located at Rocanville and Vanscoy, Saskatchewan. The Rocanville plant is located in southeastern Saskatchewan near the Manitoba border and the Vanscoy plant is located in central Saskatchewan approximately 20 miles southwest of Saskatoon. Products are used for a variety of applications such as highway de-icing, livestock feed supplements, hide curing, drilling muds, water softening, road stabilization, and industrial applications.

In Alberta, The Canadian Salt Company Limited, at Lindberg, produces fine vacuum pan salt, which is also used for water softening, agriculture, and food processing, as well as some de-icing salt for local use.

Other companies known to produce salt (mainly brine) are as follows:

- In Saskatchewan, IMC Esterhazy Canada Limited Partnership (formerly known as International Minerals & Chemical Corporation [Canada] Global Limited) supplies by-product rock salt from its potash operation at Esterhazy to Kayway Salt, who is distributing it locally for road de-icing. Saskatoon Chemicals ("SaskChem," a division of Sterling Chemicals Holdings, Inc.) produces brines from wells near Saskatoon for the manufacture of caustic soda, chlorine and sodium chlorate to be used internally for its pulp chemicals operations.

- In Alberta, Dow Chemical Canada Inc. at Fort Saskatchewan near Edmonton extracts salt brines for the manufacture of chlor-alkali. Nexen Inc. (formerly known as Canadian Occidental Petroleum Ltd. [Canadian OXY Ltd.]) and Albchem Industries Ltd. (where the plant site is located on the large and very pure Upper Lotsberg salt deposit), near Bruderheim, operate solution mines to produce sodium chlorate used mostly for pulp bleaching in the Prairie Provinces and western Canada.

METHODS OF RECOVERY

The type of salt produced is a function of geology, geography and climate, and important rock salt deposits occur in central and eastern North America and Europe, and in large areas in the Middle East. Solar salt accounts for the bulk of production in Australia, Mexico, Chile, the western United States, China, India, and Brazil, where the climate is suitable.

Rock Salt Mining

Rock salt is mined by the room-and-pillar method, which is similar to that used in coal and trona mining. The pillar widths are controlled by the percentage of extraction permissible at the various depths and room widths. Most room-and-pillar operations recover about 45-65% of the resource, with the remainder left behind as pillar supports

for the structural integrity of the mine. The salt is drilled, cut, blasted, mucked, crushed and transported to the surface for processing, which usually involves removing the impurities and screening the material to finer-size fractions. The mining of bedded deposits usually involves roof bolting haulageways and permanent work areas.

Underground mining practices for bedded halite (commonly referred to as "rock salt") and domal salt formations are similar except for the height differences within the mines of the two types of operations. For example, bedded formations usually are laterally extensive, but are vertically restricted. Salt domes are laterally restrictive, but are vertically extensive. Many salt domes have depths in excess of 6100 m (20 000 feet), yet many outcrop at the surface. Most Gulf Coast salt mining operations are generally less than 300 m (1000 feet) below the surface. Working at deeper depths is difficult because of higher temperatures and denser rocks.

Salt domes are therefore large cylindrical bodies that have been thrust up from buried deposits of rock salt through underlying layers of sediments by static pressure. Salt domes have been penetrated during exploration drilling for oil in Germany, Russia, Romania, the Persian Gulf region, and in the Gulf Coast district of the United States where several hundred salt domes are known. In Canada, salt domes are believed to exist on a few of the Arctic Islands.

The advantages of rock salt mining, when compared to solution or evaporation methods, are that rock salt can generally be produced at a lower cost, a wider range of sizes is possible, and the production rate is higher. The production size ranges from -16 mm to -3 mm. The chief disadvantage is the purity of salt produced, which varies from 95 to 98% NaCl.

Solution Mining

Holes are drilled into deep salt deposits, an injection well is sunk, and pressurized freshwater is introduced to hydraulically fracture the bedded salt. Once communication with the production well is established, the brine is pumped to the surface for treatment. Solution mining can also use annulus injection, which introduces the solvent at the bottom of the tube. A computer simulation of the cavity is kept and oil is added, as required, to maintain a desired thickness of oil at the top of the cavity. Every two years, a sonar log is performed to verify the cavity size and to correct any discrepancies with the simulated model. By controlling the quality of the water being injected into the well and the area being brined, the resultant brine is of the highest purity possible.

Solution mining is used to obtain a sodium chloride feedstock for vacuum pan salt production and for chlorine, caustic soda, and synthetic soda ash manufacture. The quantity of underground salt dissolved and recovered as brine to make vacuum pan salt usually is not reported. Only the quantity of vacuum pan salt manufactured is reported as primary salt production. The quantity of brine used to make chlor-alkali chemicals is reported as either the amount of captive brine used or brine sold. The chemical industry is the largest consumer of salt brine in the world.

Processing Rock Salt

Crushing and screening to the proper physical size is usually the only processing that road salt undergoes. In many operations, these steps are done underground in the mine to minimize haulage and storage costs. In addition, the extremely fine fraction, which often is unusable and would represent a waste product if brought to the surface, remains underground.

An exception to this procedure is the use of colour sorting and the thermoadhesive process to upgrade bedded rock salt products from an average sodium chloride content of 97% to a product with a content higher than 99.0%. The colour sorter depends on the translucence of salt and a jet of compressed air. The thermoadhesive process depends on the absorption of light by dark-heated particles of anhydrite, shale and dolomite.

The purest grades of commercial salt are produced by the treatment of fine crystal, 1.7-mm rock salt in a recrystallizer. The fine granular rock salt is dissolved in high-temperature brine in the production of a very pure hot brine. The salt produced by the recrystallizer may be as pure as 99.99% NaCl. Salt is produced in the evaporator by flash evaporation and by cooling.

Standard means for producing granulated salt for human consumption is by either the enclosed vacuum pan or open-pan methods.

Solar Salt

Salt can be obtained from seawater along coastal margins and from landlocked bodies of natural saline water and artificial brines. Salt production uses the wind and the sun to evaporate the water, leaving behind relatively pure crystals of salt. Solar salt production is restricted to areas of the world that have high evaporation rates and low precipitation.

Mechanical Evaporation

Vacuum pan salt is not mined, but is a type of salt produced using mechanical evaporation technology. Although rock salt and salt brine may be used to make vacuum pan salt, virtually all domestic vacuum pan salt is obtained from solution mining underground salt formations. Vacuum pan salt is obtained by dehydrating brine using heat alone or in combination with a vacuum. The

vacuum pan process conserves energy by utilizing multiple-effect evaporators connected to vacuum pumps. A saturated salt solution will boil at a higher temperature than pure water. When a vacuum is applied, the brine boils at a lower temperature, enabling the superheated vapour that is generated to act as the heating medium for the next evaporator.

The grainer or open-pan process uses open rectangular pans with steam-heated immersion coils to evaporate the water in the brine. Rotating rakes scrape the salt precipitate into a sump or up a ramp, depending on the method, and onto conveyors for debrining and drying treatment. The final product is usually flake shaped rather than the typical cubic form. Flake salt is preferred for the production of cheese, butter and baked goods.

The Alberger process is a modified grainer operation that produces cubic salt with some flake salt. The pans are shallow, circular units with external heating units, rather than heating coils. The open-pan process cannot be operated successfully in regions with high humidity because the evaporation rate is too slow and more energy is required to evaporate the brine.

APPLICATIONS

The direct and indirect uses of salt number about 14 000, according to industry sources.

Aside from the different types of salt, there are various distinctions in the packaging and applications of salt. Salt for human consumption is packaged in different-sized containers for several specialized purposes. Table salt may contain 0.01% potassium iodide as an additive, which provides a source of iodine that is essential to the oxidation processes in the body. Kosher salt, sea salt, condiment salt and salt tablets are special varieties of salt.

Water conditioning salt and animal feed salt are made into 22.7-kg (50-lb) pressed blocks. Sulphur, iodine, trace elements, and vitamins are occasionally added to salt blocks to provide nutrients not found naturally in the diet of certain livestock. Salt is also compressed into pellets that are used for water conditioning.

Chemical Uses

Within the chemical industry, which is a heavy consumer, if not the largest consumer, of salt brine, the chlor-alkali sector remains the major consumer of salt for manufacturing chlorine, co-product sodium hydroxide, and synthetic soda ash. Salt is used as the primary raw material in chlorine manufacture because it is an inexpensive and widely available source of chlorine ions. Salt is also used as feedstock in chemical establishments that make sodium chlorate, metallic sodium, and other downstream chemical operations. For example, in powdered soaps and detergents, salt is used as a bulking agent and a coagulant for colloidal dispersion after saponification; in pharmaceuticals, salt is a chemical reagent and is used as the electrolyte in saline solutions.

Ice Control and Road Stabilization

The second largest or largest end use of salt (in the United States and Canada, respectively) is for highway de-icing. Applied to snow or ice, once melted, brine forms below the surface and prevents the water from freezing into ice and bonding with the road surface, thus causing the snow and ice to melt. Salt is an inexpensive, widely available and effective ice control agent. It does, however, become less effective as the temperature decreases below about -9.5 to -6.5°C (15 to 20°F). At lower temperatures, more salt would have to be applied to maintain a higher brine concentration in order to provide the same degree of melting.

Salt is also added to stabilize the soil and to provide firmness to the foundation on which highways are built, particularly for stabilizing clay, and sand and gravel aggregate used in the base of primary roads and the surface of secondary roads. The finer grades of salt generally are used in most road-stabilizing programs. The salt acts to minimize the effects of shifting caused in the subsurface by changes in humidity and traffic load.

Distributors

A tremendous amount of salt is marketed through various distributors, some of which specialize in markets such as agricultural and water treatment services, two sectors where the salt companies also have direct sales.

General Industrial Uses

The industrial uses of salt are diverse. They include, in descending order, oil and gas exploration, other industrial applications, textiles and dyeing, metal processing, pulp and paper, tanning and leather treatment, and rubber manufacture.

In oil and gas exploration, salt is an important component of drilling fluids in well drilling. It is used to flocculate and increase the density of the drilling fluid to overcome high down-well gas pressures. Wherever a drill hits a salt formation, salt is added to the drilling fluid to saturate the solution and to minimize the dissolution within the salt stratum. Salt is also used to increase the set rate of concrete in cemented casting.

In textiles and dyeing, salt is used as a brine rinse to separate organic contaminants, to promote “salting out” of dyestuff precipitates, and to blend with concentrated dyes to standardize them. One of its main roles is to provide

the positive ion charge to promote the absorption of negatively charged ions of dyes.

In metal processing, salt is used in concentrating uranium ore into uranium oxide (yellow cake). It is also used in processing aluminum, beryllium, copper, steel and vanadium.

In the pulp and paper industry, salt is used to bleach wood pulp. It is also used to make sodium chlorate, which is added along with sulphuric acid and water to manufacture chlorine dioxide, an excellent oxygen-based bleaching chemical. The chlorine dioxide process, which originated in Germany after World War I, is becoming more popular because of environmental pressures to reduce or eliminate chlorinated bleaching compounds.

In tanning and leather treatment, salt is added to animal hides to inhibit microbial activity on the underside of the hides and to replace some of the moisture in the hides.

In rubber manufacture, salt is used to make styrene-butadiene rubber, neoprene, and white types. Salt brine and sulphuric acid are used to coagulate and emulsify latex made from chlorinated butadienne.

Agricultural Industry

Wild animals satisfy their salt hunger by locating salt springs, salt licks, or playa lake salt crusts. Barnyard and grazing livestock need supplementary salt rations to maintain proper nutrition. Veterinarians advocate adding loose salt in commercially mixed feed or in block forms sold to farmers and ranchers because salt acts as an excellent carrier for trace elements not found in the vegetation consumed by grazing livestock; selenium, sulphur and other essential elements are commonly added to salt blocks for free-choice feeding.

Food Processing

Every person uses some quantity of salt in their food. The salt is added to the food by the food processor or by the consumer through free choice as a flavour enhancer, preservative, binder, fermentation-control additive, texture-control agent, and colour developer. This major category is subdivided, in descending order of salt consumption, into other food-processing categories such as meat packing, canning, baking, dairy, and grain mill products.

In meat packing, salt is added to processed meats to promote colour development in bacon, ham and other processed meat products. As a preservative, salt inhibits the growth of bacteria, which would lead to spoilage of the product. Salt acts as a binder in sausage to form a binding gel composed of meat, fat and moisture. Salt also acts as a flavour enhancer and a tenderizer.

In the dairy industry, salt is added to cheese as a fermentation-control agent and as a colour- and texture-control agent. The dairy subsector includes companies that manufacture creamery butter, natural and processed cheese, condensed and evaporated milk, ice cream, frozen desserts, and specialty dairy products.

In canning, salt is primarily added as a flavour enhancer and preservative. It is also used as a dehydrating agent, tenderizer, enzyme inhibitor, and carrier for other ingredients.

In baking, salt is added to control the rate of fermentation in bread dough. It is also used to strengthen the gluten (the lastic protein-water complex in certain doughs) and as a flavour enhancer, such as a topping on baked goods.

The food-processing category also contains grain mill products, which consist of milling flour and rice and manufacturing cereal breakfast food and blended or prepared flour.

In the “other food processing” category, salt is used mainly as a seasoning agent. Other food processing includes miscellaneous establishments that make food for human consumption (such as potato chips and pretzels) and for domestic pet consumption (such as cat and dog food).

Water Treatment

Many areas have hard water, which contains excessive calcium and magnesium ions that contribute to the build-up of a scale or film of alkaline mineral deposits in household and industrial equipment. Commercial and residential water-softening units use salt to remove the ions causing the hardness. The sodium ions captured on a resin bed are exchanged for the calcium and magnesium ions. Periodically, the water-softening units must be recharged because the sodium ions become depleted. Salt is added and dissolved, and the brine replenishes the lost sodium ions.

PRICES

Salt has unique production, processing and packaging factors that determine its selling prices. The price of salt depends on the type of salt, location, product form, and the type of sale. Generally, salt sold in bulk is less expensive than salt that has been packaged, pelletized, or pressed into blocks. Salt in brine is the least expensive salt sold because mining and processing costs are less. Vacuum pan salt is the most expensive because of the higher energy costs involved in processing it and the purity of the product.

Due to the unavailability of prices from Canada's salt industry, the following price examples from other sources are provided. The May 2004 edition of *IM Magazine* reported that salt prices (ground rock salt, 15-20 short ton lots, average price delivered U.K.) were in the range of £20-£30 (converted: C$50.09-$75.14). As a basis of comparison (source: USGS) for the North American market, 2002 average prices (net selling value, free on board plant, excluding container costs, U.S. dollars per metric ton) are as follows: bulk (vacuum pan and open pans, $58.12; rock, $20.10; brine, $5.89); compressed pellets (vacuum pan and open pans, $134.61; rock, not available (n.a.); brine, n.a.); packaged (vacuum pan and open pans, $135.39; rock, $70.62; brine, n.a.); and pressed blocks (vacuum pan and open pans, $107.18; rock, $101.81; brine, n.a.).

Canadian producers and others are well aware of the globalization factor affecting prices. A slight difference in price can result in usual orders made in previous years being lost to a foreign competitor.

HEALTH/ENVIRONMENTAL ISSUES

Health Concerns

In Canada, the Workplace Hazardous Materials Information System (WHMIS) (see www.hc-sc.gc.ca/hecs-sesc/whmis/) is Canada's hazard communication standard. WHMIS is implemented through coordinated federal, provincial and territorial legislation for working environments.

Each human being contains about four ounces of salt and, unless we get enough of it in our diet, our muscles won't contract, our blood won't circulate, our food won't digest and our hearts won't beat. Therefore, reasonable consumption of salt is good for human health.

Environmental Concerns

The effects of salt-spreading on the environment depend on a variety of factors such as weather conditions, road characteristics, traffic loads, winter maintenance methods, and local topography. Environmental effects may include adverse impacts on plant growth and crop productivity in the immediate vicinity of highways, as well as higher salinity levels in streams and groundwater systems. Because of its low price, de-icing salt is the favoured de-icing agent. The optimization of spreading rates, in combination with the search for adequate abrasive mixtures, will continue to be evaluated. For many years, provincial/territorial and regional agencies in charge of road maintenance have pursued the objective of optimizing the use and selection of ice and snow control methods. Cost, operational reliability, public safety, and environmental issues must be considered, and these agencies will continue to evaluate improvements to existing methods and better road safety and rideability.

Although the benefits of de-icing agents were recognized by the Environment Minister's Expert Advisory Panel on the Second Priority Substances List, the Panel recommended that they be assessed for potential impact on the environment but that "any measures developed as a result of the assessment must never compromise human safety." The overall conclusion of Environment Canada's *Canadian Environmental Protection Act, 1999* (CEPA 1999) report entitled *Priority Substances List Assessment Report – Road Salts* is as follows: "Based on the available data . . . it is concluded that road salts that contain inorganic chloride salts with or without ferrocyanide salts are 'toxic' as defined in Section 64 . . ."

A working group that includes representatives of governments, industry and environmental groups met three times in 2002 to discuss best practices for the application and storage and disposal of road salt, and to develop a guideline under CEPA 1999. In April 2004, Environment Canada issued a Code of Practice for the Environmental Management of Road Salts. The Code applies to any organization that uses more than 500 t of road salts per year. These organizations have to prepare and implement a salt management plan that contains best management practices to protect the environment from the negative impacts of road salts. Environment Canada will review the effectiveness of the Code after five years and decide whether further steps are needed to protect the environment. The salt industry hopes that the Code is effective and that Environment Canada does not act on a recommendation that road salts be added to Canada's list of toxic substances.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 64. (2) Information in this review was current as of May 31, 2004. (3) This and other reviews, including previous editions, are available on the Internet at www.nrcan.gc.ca/mms/cmy/com_e.html.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2501.00	Salt (including table salt and denatured salt) and pure sodium chloride, whether or not in aqueous solution or containing added anti-caking or free-flowing agents; sea water				
2501.00.10	Table salt made by an admixture of other ingredients when containing 90% or more of pure sodium chloride	2.5%	Free	Free	Free
2501.00.90	Other	Free	Free	Free	Free

Sources: Canadian *Customs Tariff*, effective January 2004, Canada Border Services Agency; *Harmonized Tariff Schedule of the United States*, 2004.

TABLE 1. CANADA, SALT SHIPMENTS AND TRADE, 2001-03

Item No.		2001		2002		2003	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
SHIPMENTS							
	By type						
	Mined rock salt	11 528 499	333 481	10 581 246	319 078	11 416 565	319 988
	Fine vacuum salt	844 719	86 029	870 370	89 229	914 750	94859
	Salt content of brines used or shipped	1 351 761	10 299	1 284 861	10 947	1 058 425	9 083
	Total	13 724 979	429 809	12 736 477	419 255	13 389 740	423 930
	By province						
	Nova Scotia	x	x	x	x	x	x
	New Brunswick	x	x	x	x	x	x
	Quebec	x	x	x	x	x	x
	Ontario	8 568 470	274 420	7 630 364	262 429	8 441 463	267 150
	Manitoba	–	–	x	x	x	x
	Saskatchewan	851 307	35 817	914 558	39 642	942 614	37 657
	Alberta	1 246 969	19 229	1 323 683	20 207	1 082 343	19 934
	Total	13 724 979	429 808	12 736 477	419 254	13 389 740	423 930
IMPORTS							
2501.00	Salt (1)						
	United States	1 131 620	47 941	641 654	32 380	615 967	32 165
	Mexico	292 670	5 296	436 173	8 294	235 498	4 969
	Chile	129 431	4 613	246 152	7 333	76 267	2 514
	France	7 967	806	8 286	899	12 219	1 204
	Ireland	751	64	4 829	349	3 939	437
	Greece	988	127	1 233	156	2 031	218
	Germany	717	44	925	67	2 832	179
	Belgium	25	3	191	27	1 338	175
	Bahamas	62 425	1 331	25 432	664	5 250	165
	British Virgin Islands	–	–	–	–	5 500	150
	Israel	278	48	700	91	1 208	146
	South Korea	1 393	116	1 248	124	1 031	131
	Brazil	2	–	254	29	1 006	104
	South Africa	362	26	204	25	842	90
	United Kingdom	735	73	617	57	731	79
	Portugual	489	60	746	74	583	75
	Italy	255	33	610	54	568	70
	Japan	387	197	1 364	118	622	69
	Austria	198	36	758	97	912	57
	China	3 648	154	2 754	242	482	46
	Switzerland	20	1	254	20	363	46
	India	302	28	661	25	472	46
	Netherlands	212	38	232	41	284	44
	Pakistan	209	20	176	11	425	31
	Spain	113	14	124	26	321	31
	Others	9 225	362	968	81	882	89
	Total imports	1 644 422	61 431	1 376 545	51 284	971 573	43 330

TABLE 1 (cont'd)

Item No.		2001		2002		2003	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)							
	By province of clearance						
	Newfoundland and Labrador	24 211	717	92 336	1 877	25 624	662
	Nova Scotia	6 365	122	7 041	124	5 603	161
	New Brunswick	2 656	266	3 016	290	904	95
	Quebec	324 665	11 409	269 082	9 051	90 785	5 129
	Ontario	883 923	37 408	465 421	25 108	546 461	27 943
	Manitoba	12 149	773	10 052	803	5 523	638
	Saskatchewan	2 642	409	1 987	444	2 527	327
	Alberta	11 926	1 100	7 904	748	12 439	923
	British Columbia	375 887	9 229	519 709	12 842	281 705	7 451
	Total	1 644 424	61 431	1 376 547	51 286	971 572	43 329
EXPORTS							
2501.00	Salt (1)						
	United States	4 614 073	115 831	3 663 957	96 197	4 186 836	124 649
	Honduras	–	–	–	–	2 476	137
	Barbados	182	29	23 036	46	1 497	112
	Costa Rica	89	22	233	91	271	102
	Saint Pierre and Miquelon	320	29	365	30	813	100
	Malaysia	45	1	–	–	542	37
	France	0	–	583	59	229	30
	Spain	23	4	24	4	1 183	23
	South Korea	–	–	200	5	970	20
	Saint Kitts and Nevis	52	5	250	20	1 027	16
	South Africa	–	–	17	3	69	11
	Germany	–	–	14	2	126	11
	Other countries	1 955	213	1 120	160	650	61
	Total	4 616 739	116 134	3 689 799	96 617	4 196 689	125 309

Sources: Natural Resources Canada; Statistics Canada.
– Nil; x Confidential.
(1) Includes table salt, pure sodium chloride and seawater salt.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, SALT SHIPMENTS AND TRADE, 1980-2003

	Producers' Shipments					
	Mined Rock	Fine Vacuum	In Brine and Recovered in Chemical Operations	Total	Imports	Exports
	(tonnes)					
1980	4 507 416	781 428	2 134 010	7 422 854	1 151 203	1 637 601
1981	4 371 314	764 037	2 107 243	7 242 594	1 254 992	1 507 710
1982	5 223 073	773 086	1 944 172	7 940 331	1 526 879	1 721 893
1983	5 846 994	714 464	2 040 925	8 602 383	814 250	1 914 629
1984	7 030 664	754 675	2 450 060	10 235 399	1 053 217	2 530 038
1985	6 608 739	805 209	2 670 749	10 084 697	1 255 518	2 263 076
1986	6 867 287	815 044	2 649 515	10 331 846	1 328 298	2 502 518
1987	6 670 863	866 475	2 591 715	10 129 053	1 112 102	1 924 686
1988	7 126 762	783 368	2 777 050	10 687 180	1 202 219	3 030 124
1989	7 548 732	821 284	2 788 395	11 158 411	2 360 432	2 137 321
1990	7 704 499	778 428	2 708 458	11 191 385	2 095 321	1 897 816
1991	8 615 755	799 563	2 455 541	11 870 859	1 202 880	2 783 021
1992	7 912 989	770 370	2 404 667	11 088 026	1 041 424	2 650 921
1993	8 073 435	817 859	2 101 711	10 993 005	1 051 096	3 079 298
1994	9 446 002	822 181	1 975 704	12 243 887	940 131	3 638 674
1995	8 077 661	850 676	2 029 047	10 957 384	1 294 996	2 986 802
1996	9 499 189	853 858	1 895 430	12 248 477	1 137 604	3 816 788
1997	10 923 966	863 112	1 709 778	13 496 856	1 262 822	3 634 009
1998	10 517 641	834 944	1 681 710	13 034 295	977 944	4 177 880
1999	10 004 167	823 983	1 857 745	12 685 895	1 375 141	3 808 093
2000	9 458 260	827 630	1 878 179	12 164 069	1 141 060	3 475 755
2001	11 528 499	844 719	1 351 761	13 724 979	1 644 422	4 616 739
2002	10 581 246	870 370	1 284 861	12 736 477	1 376 545	3 689 799
2003 (p)	11 416 565	914 750	1 058 425	13 389 740	971 573	4 196 689

Sources: Natural Resources Canada; Statistics Canada.
(p) Preliminary.

TABLE 3. WORLD SALT PRODUCTION, 1996-2002

	1996	1997	1998	1999	2000 (r)	2001 (r)	2002 (e)
				(000 tonnes)			
United States (1)	42 300	41 500	41 300	45 000	45 600	44 800	40 300
China	29 035	30 830	22 420	28 124	31 280	34 105	32 835
Germany	15 907	15 787	15 700	15 700	15 700	15 700	15 700
India	14 466	14 251	11 964	14 453	14 453	14 503	14 503
Canada (2)	12 248	13 264	13 296	12 686	12 164	13 725	12 736
Australia	7 905	8 801	(r) 9 033	(r) 9 888	8 778	9 536	9 887
Mexico	8 508	7 933	8 412	8 236	8 884	8 501	8 500
France	7 860	7 085	7 000	7 000	7 000	7 000	7 000
Brazil	5 384	6 516	6 837	5 958	6 074	5 578	5 600
United Kingdom	6 610	6 600	6 600	5 800	5 800	5 800	5 800
Poland	4 163	3 859	4 005	4 212	4 307	4 200	4 200
Italy	3 541	3 510	3 600	3 600	3 600	3 600	3 600
Spain	4 000	4 000	3 500	3 200	3 200	3 200	3 200
Russia	2 100	2 100	2 200	3 200	3 200	2 800	2 800
Ukraine	2 800	2 500	2 500	2 185	2 287	2 300	2 300
Other countries	37 173	38 464	41 787	(r) 40753	39 673	41 652	41 039
Total	204 000	207 000	200 000	(r) 210 000	212 000	217 000	210 000

Sources: Natural Resources Canada; U.S. Geological Survey.
(e) Estimated; (r) Revised.
(1) Excludes Puerto Rico. (2) The U.S. Geological Survey is the source for all data, excluding data for Canada, for which the source is Natural Resources Canada.
Note: Numbers may not add to totals due to rounding.

TABLE 4. CANADIAN SALT PRODUCERS

Company	Location/ Initial Production	Mill/Plant Capacity	Remarks
		(t/y)	
ERCO Worldwide	Virden, Man./2002	60	Brining to produce sodium chlorate.
	Bruderheim, Alta./1991	129	Brining to produce sodium chlorate (salt brine).
Nexen Inc.	Bruderheim, Alta./1991	100	Brining to produce sodium chlorate (salt brine).
Canadian Salt Company Limited, The	Pugwash, N.S./1959		Rock salt.
	Pugwash, N.S./1963	7 800	Brine made from mined rock salt used to produce fine evaporated salt (rock salt).
	Iles-de-la-Madeleine, Que./1982	4 800	Rock salt.
	Ojibway, Ont./1955	10 300	Salt graded and prepared for markets (rock salt).
	Windsor, Ont./1892	710	Evaporated salt.
	Belle-Plaine, Sask./1969	650	Plant uses sodium chloride brines produced at the nearby potash solution mine of IMC Canada Ltd. (evaporated salt).
	Lindbergh, Alta./1968	400	Produces coarse and fine salt (evaporated salt).
Dow Chemical Canada Inc.	Fort Saskatchewan, Alta/1967	3 500	Brining to produce caustic soda and chlorine (salt brine).
General Chemical Canada Ltd.	Amherstburg, Ont./1919	–	Brining to produce sodium carbonate and chloride. Discontinued operation in April 2001.
IMC Canada Ltd., a subsidiary of IMC Global Inc.	Colonsay, Sask./1969	–	Various grades of salt are also produced. Discontinued operation in June 2001.
IMC Global Inc.	K1 & K2 mine, Esterhazy, Sask./1962	180	By-product rock salt from potash mine (standard, coarse and granular grades).
NSC Minerals Inc.	Rocanville, Sask./1990	200	Produces coarse and fine products (rock salt).
	Vanscoy, Sask./1988	300	Produces coarse and fine products (rock salt)
Potash Corporation of Saskatchewan Inc., New Brunswick Division	Sussex, N.B./1983	700	Three grades of muriate of potash (KCl) are produced from a flotation circuit and a crystallizer circuit (salt).
Sterling Pulp Chemicals (Sask) Ltd.	Saskatoon, Sask./1979	130	Primarily a manufacturer of pulp and water treatment chemicals. Brining to produce caustic soda, chlorine and sodium chlorate.
Sifto Canada Inc.	Amherst, Nappan, N.S./1947	312	Brining for vacuum pan evaporation (evaporated salt).
	Goderich, Ont./1959	26 000	Rock salt mining.
	Goderich, Ont./1872	326	Brining for vacuum pan evaporation (evaporated salt).
	Unity, Sask./1949	408	Brining for vacuum pan evaporation (evaporated salt).

Source: Natural Resources Canada, company surveys.