NITRATES.

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Nitrogen for use in manufactures and in agriculture is supplied principally in the form of nitrates, and as these salts, or the nitric acid derived from them, constitute the basis of practically all explosives, they are absolutely essential also to warfare. As they are among the chief salts used in chemical fertilizers an adequate supply of them affects directly the quantity and the quality of the food supply.

Nearly all the sodium nitrate marketed is obtained from extensive deposits in the desert region of northern Chile. Commonly a few thousand tons of potassium nitrate is imported annually from India, where it is artificially produced in "saltpeter plantations." Calcium nitrate obtained in Norway by artificial fixation of the nitrogen of the atmosphere has also been listed among the fertilizer materials marketed in this country. The United States has been the largest purchaser of Chilean nitrate since the German market has been cut off. Just after the outbreak of the European war the Chilean nitrate industry experienced a severe depression, which has, however, been followed by gradual recovery. The cost of production at the mines has risen considerably, owing largely to the increased cost of labor and the scarcity and high price of fuel. The coal used for refining the nitrate has been obtained principally from Wales as return cargo in the nitrate vessels. Fuel oil from California is also used.

At present the dearth of shipping facilities and high freight rates have considerably increased the price of the nitrate in the countries to which it is exported.

Nitrate of soda exported from Chile, calendar years 1912–1915, in short tons.[a]

1912	2,748,124	1914	2,035,707
1913	3,018,469	1915	2,230,054

A general idea of the importance of nitrates in this country may be obtained from the statistics of imports, which practically represent the domestic consumption, there having been no domestic production

[a] The figures for 1912–1914 are from Anuario estadístico de la República de Chile, Minera y metalurgia, vol. 7, 1914, p. 67, Santiago de Chile, 1915. Those for 1915 are from Supplement to Commerce Repts., Ann. Ser., No. 41b, p. 5, Nov. 10, 1916.

of consequence. The rated values given with import returns, which perhaps represent cost exclusive of freight, are lower than the usual market quotations. For instance, the normal New York quotations for sodium nitrate, 95 per cent pure, ranged from $44 to $52 a short ton in 1912 and from $44.40 to $52.40 in 1913. At the end of 1916 or early in the spring of 1917 sodium nitrate was quoted at $75 a ton in Atlantic ports.

Nitrate salts "entered for consumption" in the United States, 1912–1916.[a]

Calendar year.	Sodium nitrate.		Potassium nitrate.	
	Quantity (short tons).	Approximate rated value per ton.	Quantity (short tons).	Approximate rated value per ton.
1912	545,192	$30.00	3,256	$62
1913	686,404	31.50	4,826	54
1914	611,218	25.00	1,115	67
1915	863,103	26.50	3	117
1916	1,365,962	28.00	5,769	263

[a] Figured from statistics of the Department of Commerce.

The import figures show a war-time stimulus, the normal annual domestic consumption of about 600,000 tons of sodium nitrate increasing to more than double this amount in 1916. Of this large increase between 100,000 and 200,000 tons is believed to be in storage as a reserve for the time when access to a foreign supply may be cut off. The remainder of the increase, probably 600,000 tons, may be assumed to have gone into munition manufacture, chiefly for export.

The amount of nitrates consumed in fertilizers is not known exactly, but about 280,000 short tons (250,000 long tons) of sodium nitrate was used in 1916 for direct application to the soil as fertilizer. It is said to be applied chiefly as a top dressing, by itself, to promote or hasten growth at certain seasons, usually in the spring, after the crop has made a start.

A very important use for sodium nitrate is in the manufacture of sulphuric acid by the chamber process. In this process, by which the greater part of the acid of low gravities produced in this country is made, the nitric acid is required for the oxidation of the sulphurous gases to sulphuric form. The weight of sodium nitrate used in this way is estimated to be about 5 per cent of the weight of the sulphur consumed to make the sulphuric acid. The production in 1916 of 4,500,000 tons of sulphuric acid of strengths less than 66° Baumé therefore required 75,000 long tons (nearly 85,000 short tons) of sodium nitrate.

There are many other industrial uses of nitrates for which, at present, accurate statistics are not available. The following estimated summary is therefore given in general terms:

Sodium nitrate consumed in the United States in 1916.

	Quantity (short tons).	Approximate percentage.
Explosives	600,000	45
Fertilizers	280,000	20
Manufacture of sulphuric acid	85,000	5
Miscellaneous, including stocks in storage	400,000	30
	1,365,000	100

Unfortunately there is in the United States no natural source of nitrate salts that seems to promise an important supply. Small deposits yielding remarkably rich specimens have been found in many places throughout the country, and during former war times saltpeter for use in making gunpowder was obtained by crude leaching methods from minor deposits in caves. The total amount obtained in this way was probably not very large, and in comparison with the greatly increased rate of consumption in explosives and industrial uses the supply obtainable from such sources would be at best an almost negligible contribution for present needs, even on the assumption that these small deposits would be worth working again as they were in the past, an assumption which is probably not warranted. This subject has been carefully studied by the United States Geological Survey in the hope of finding some source of sufficient promise to justify exploitation, if only as a war-time emergency, but the conclusions have been essentially negative.

There are in several of the Western States considerable deposits of nitrate-bearing earths or clays which have been found to contain in places from 2 to perhaps 5 or 6 per cent of sodium nitrate, in conjunction with sodium sulphate and chloride, and it is conceivable that these deposits might be worked by leaching and some method of crystallization to separate the salts. These deposits are of very doubtful importance, however, on account of the difficulty in recovering a small percentage of nitrates by methods now in use or known. On the whole there is within the United States no known natural source of nitrates that can be counted on to furnish any considerable supply of the refined nitrate salts. This statement does not refer to the bacterial development of nitrates in soils through processes connected with cultivation and cropping, which is of course an important aid to agriculture but does not come within the scope of the present account of extractable nitrate salts.

The importance of the nitrate supply is recognized by an act of Congress approved June 3, 1916, which appropriated $20,000,000 to enable the President to make an investigation of the best, cheapest, and most available means for the "production of nitrates and other products for munitions of war and useful in the manufacture of fertilizers," by water power or any other means, and which authorized the President to construct, maintain, and operate the plants and

equipment necessary to produce these materials. The product is to be used for military and naval purposes so far as it is needed, and any surplus may be sold for other uses.

The processes for fixation of atmospheric nitrogen that have been developed in a practical way may be classified as the arc processes, the Haber process, and the cyanamid process. The arc processes involve direct oxidation by means of the electric arc to form nitric acid and nitrates. These are fundamentally the simplest but are limited in application by the great amount of electric power required. Norway, with abundant water power, has been able to employ these processes successfully, but it seems doubtful if the power available in this country could be spared for use in this way. The Haber and cyanamid processes form other compounds of nitrogen, which, however, can be converted into nitrates by a further process. The Haber process consists in forcing gaseous nitrogen and hydrogen to combine under high pressure, a reaction being effected with the aid of a catalytic agent. This process yields ammonia which would have to be converted to nitric acid, at least in part, to supply munition requirements, but which could be used in agriculture by conversion into ammonium phosphate or sulphate. This process, together with one for obtaining ammonia from cyanamid, is used at present in the production of nitric acid for munition supplies and inorganic nitrogen fertilizer salts in Germany, and these industries are believed to have been developed to such a degree as to render that country entirely independent of outside sources of nitrates when the war requirements cease. The cyanamid process consists in the production of a compound of lime, nitrogen, and carbon, known as calcium cyanamid. It involves two main steps, each based on electric-furnace treatment but requiring only about one-fifth the power expenditure of the arc process. It is said that calcium cyanamid must be converted into ammonium salts to meet the requirements of nitrogen-carrying mixed fertilizer. An additional step would be necessary to convert the product to a nitric form.

By-product ammonia, derived from the production of coke and of illuminating gas, is an important source of combined nitrogen and is an available source for the production of nitric acid or nitrates. Such ammonia can be practically oxidized to nitrates, and the supply of this material is therefore available to relieve emergency requirements should other sources fail.

Thus it appears that measures are now being taken to insure the country a nitrate supply. As not all these measures would be immediately effective in case of unforeseen emergency, it is assumed that reserves have been accumulated which will tide over any temporary emergency that may arise.