THE POTASH INDUSTRY IN INDIA.

By H. B. DUNNICLIFF, *Central Revenues Control Laboratory, New Delhi, and* MATA PRASAD, *Royal Institute of Science, Bombay.*

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Potassium salts are widely distributed in nature and in India the potential sources may be classified as follows:—

1. (*a*) Lake brines.
   (*b*) Sea-water.
   (*c*) Underground brines.
   (*d*) Swamp brines.
2. Saline earths or efflorescences giving potassium nitrate and containing also potassium chloride and sulphate.
3. Salt mines such as those at Khewra in the Salt Range and in Mandi State.
4. Other minerals such as alunite (K_2SO_4, $Al_2(SO_4)_3$, $4Al(OH)_3$), felspar (K_2O, Al_2O_3, $6SiO_2$), etc.
5. Flue gases and cement kiln dust.
6. Animal sources such as wool washings and sheep dung ash (karro ash).
7. Vegetable sources, like molasses, bagasse, wood ashes and the ash of the water hyacinth which grows profusely in Bengal.

Of all these sources of potassium only (1) and (2) appear to be of commercial importance in India in present circumstances.

Mineral Sources.

A number of deposits containing potassium occur in the Salt Range in Northern India, though the quantity of these salts associated with the rock salt deposits is smaller than would be expected. The salts so far identified are sylvine or potassium chloride (KCl), langbeinite (K_2SO_4, $2MgSO_4$) and kainite (KCl, $MgSO_4$, $3H_2O$).

Dr. Warth discovered these deposits in the Mayo Salt Mine at Khewra in 1873. Dr. W. A. K. Christie in his 'Notes on the Salt Deposits of the Cis-Indus Range' (*Rec. Geol. Surv. Ind.*, 1914, XLIV, 243) investigated the potassium-bearing salts of this mine and found that seams varied up to $7\frac{1}{2}'$ thick and averaged 6·8 to 9·6% potassium oxide in four seams and 14·4% potassium oxide in the case of a seam only about 2′ thick. Later, Dr. Murray Stuart in his article 'The Potash Salts of the Punjab Salt Range and Kohat' (*Rec. Geol. Surv. Ind.*, 1919, 28) reported on the saline deposits of Nurpur and

Warcha in the Salt Range and Kalabagh and Kohat in the trans-Indus region. He concluded that no continuous bed of potassium salts had been proved in these areas and expressed the opinion that it was unlikely that these salts would prove workable except possibly as a by-product during the normal course of mining for rock salt. In general, reports indicate that there are not workable quantities of salts at these places, but it has been suggested that these potential sources of potassium compounds should be re-investigated.

The other minerals contain potassium in very small quantities and no suggestion has yet been made to work them for potassium compounds.

Flue Gases and Cement Kiln Dust.

In Bulletin No. 42 of Indian Industries and Labour, it is stated that blast furnace dust contains potassium salts to a total content of 40–45% and that this source of potash is worth investigation. Further, it is claimed that, on account of the considerable amount of the iron ore smelted, it should be possible to produce potash from the flue dust at a steady rate which would go some way to meet the needs of agriculturists in India. This bulletin also states that the Katni Cement & Industrial Co. and the Jubbulpore Portland Cement Co. could produce 1 ton of potash per day, but the cost of production would be heavy.

In most cases, potassium salts present in the ore volatilise off. Whenever this does not happen, volatilisation is promoted by the addition of sodium chloride to the charge. In Britain, either electrical precipitation by Cottrell's method or a water spray process is used in the recovery of potash salts from these sources. In the cement kiln process, the gases leaving the kiln at 380° pass through a dust settling chamber where the temperature falls to 230° and thence to a spraying chamber. The liquid from the spraying chamber is filtered and evaporated to crystallise out the potash salts. The accumulation in the dust chamber is also leached with water and the solution similarly treated.

Animal Sources.

Suint: Wool washings containing wool fat or suint are evaporated to dryness and ignited, potassium carbonate being extracted from the residue by lixiviation with water. The composition of the salt obtained is as follows:—

	Potassium carbonate. %	Potassium sulphate. %	Potassium chloride. %	Sodium carbonate. %	Insoluble. %
1st grade	93·0	0·5	2·0	4·5	0·04
2nd grade	87·0	5·1	4·9	2·7	0·07

Vegetable Sources.

(*a*) *Molasses.*—Investigations on the recovery of potassium salts from molasses (5–15% K_2O) are being conducted by Dr. A. V. Varadaraja Iyengar at the Indian Institute of Science, Bangalore, Professor P. Ray and Dr. B. K. Mukherji at the University College of Science, Calcutta, and Mr. Walawaker, financed by the Department of the Scientific and Industrial Research. Most of these methods contemplate the use of a reagent which may form an insoluble salt with a potassium compound, capable of regeneration without appreciable loss when the insoluble salt is treated with an acid.

(*b*) *Bagasse.*—The ash of bagasse which is used as a fuel in many sugar factories is obtained as a glassy fused mass containing about 7·5% of potassium oxide.

(*c*) *Water Hyacinth.*—The ash of water hyacinth (about 25% K_2O) is a potential source of potassium chloride, but the enormous bulk of the material and the difficulties of collection, desiccation and combustion of the dried material make the prospects of success in this process doubtful.

(*d*) *Wood, etc.*—Dr. E. J. Russell writes of the commercial possibility of the production of potash salts from such forest products as wood, wood waste, hedge clippings and trimmings and saw-mill waste (*Indian Trade Journ.*, Vol. 39, 1915).

Wood is largely used in India as fuel and the prospects of extraction of soluble potash salts from Indian village ashes have been considered by Mr. J. W. Leather (*Indian Trade Journ.*, Vol. 38, 1915).

The percentage of potash present in Indian village ashes from various localities as recorded by him are given below:—

TABLE I.

Potash Content of Indian Village Ashes.

	Total.	Soluble in Water.
Peshawar	1·35	0·21
Lyallpur	2·60	1·15
N.W. Frontier Province ..	3·26	3·05
Punjab	2·95	1·37
U.P., Orai	4·16	1·4
Bombay, Manjri ..	2·49	..
Central Provinces ..	1·65–4·30	0·16–2·53
Madras, Bezwada ..	1·9	0·53
Bengal	6·7–3·44	3·32–4·28
Assam, Kamrup ..	10·67	6·38

Leather estimated that the cost of extraction would be about Rs.200 per ton of potash salts and concluded that Indian village ashes can hardly hope to form a useful source of potash. However, these records are very old and it might be worth while to investigate anew the problem of the recovery of potash from this source and from cement kiln dust.

The Demand for Potash Salts in India.

The bulk of the potash salts required for various purposes is imported from foreign countries. Table II shows the import figures for the years 1937-38 to 1941-42 :—

TABLE II.

Imports of Potassic Compounds into British India.

	Quantities in tons.				
	1937-38.	1938-39.	1939-40.	1940-41.	1941-42.
I. *Manures*—					
(*a*) Muriate of potash	2,928	1,929	2,110	1,585	100
(*b*) Other potassic manures ..	1,604	965	1,045	140	..
II. *Chemicals*—					
Potassium compounds	2,822	2,118	2,751	2,317	1,707

These imports are principally for Bengal and Madras Presidencies, probably for manuring tea, coffee, cocoanut and rubber plantations.

Nowadays, very large quantities of potassium salts are required for the manufacture of such compounds as the dichromate, chlorate, hydroxide, etc. It is computed that 2,000 tons of potassium salts will be required annually in the manufacture of dichromate alone in Bombay, Madras and Mysore.

Potassium chlorate is urgently demanded by the Indian match industries in large amounts. Investigations for its manufacture undertaken at the Indian Institute of Science, Bangalore have yielded successful results on a small scale. The Board of Scientific and Industrial Research has recently sanctioned a grant for the erection of a pilot plant for the manufacture of potassium chlorate. The production of the required amount of this salt would also need potassium chloride to the extent of several hundred tons per annum.

Production of Potash Salts in India.

The sources of potassium salts manufactured in India at the present time are sea-water, certain subterranean brines and the saltpetre industry. No potassium salts are made from Indian lake brines but a few comments on this subject are included to show that this theoretical source of potassium salts has not been overlooked.

Indian Lake Brines.—In a note on the Lonar Soda Deposit by W. A. K. Christie (*Rec. Geol. Surv. India*, 1912, XLI, 276), analyses are given showing the potash content of various products as ranging from 4·28 to 10·29% potassium oxide, though no mention is made of such notable potassium content in the note on Lonar Lake by E. R. Gee (*Rec. Geol. Surv. Ind.*, 1935, LXX,

438), while, on page 284 of his article (*loc. cit.*), Dr. Christie makes some pertinent comments on the low content of the potassium in the lake water. No attempt has been made to recover potassium salts from this source. Attention is also invited to the note by Dr. P. K. Ghose (*Rec. Geol. Surv. Ind.*, 1934, LXVIII, 244) in which he gives analyses of reshta salt (wind salt) from Sambhar Lake (Rajputana Salt Sources) showing 7·3–8·19% potassium oxide. This is somewhat curious, as recent analyses of reshta salt from that source have shown potassium to be absent and that the concentrated East Lake bitterns only contain 0·3–0·4% potassium chloride. One of the most noticeable features of all the brines from Sambhar, Gudha, Nawa, Didwana and Pachbadra is the negligible percentage of potassium salts present.

(1) *Sea.*—Exhaustive investigations on the recovery of potassium chloride on a large scale from sea bitterns have been conducted by Messrs. Tata Chemicals Ltd., at Mithapur in the Rann of Cutch under the direction of Mr. Kapil Ram Vakil, the Technical Director, and the scheme for their manufacture has been completed. Production of potassium chloride has already commenced and the probable output will be 300–400 tons of 85–90% grade salt per annum. The Grax Salt Works recently floated at Karachi also propose to make potassium chloride.

In the salt factories of the Madras Presidency, the bitterns of the density between 29° and 33° Bé containing 5·0% potassium chloride on the solid residue are usually run to waste. Attempts could also be made to obtain the quantity of potassium chloride available from this source and from Madras swamp brines. The method for its recovery has been already worked out in the laboratory of the Indian Institute of Science, Bangalore.

Table III gives an idea of the amount of potassium chloride per litre of bitterns recently determined in the bitterns from a number of places named in Madras Presidency showing a high percentage of the salt:—

TABLE III.

Salt Factory.	Grams of potassium chloride per litre of bitterns.	Salt Factory.	Grams of potassium chloride per litre of bitterns.
Ganjam	21·7	Krishnapatam ..	16·9
Covelong	11·8	Chinnaganjam ..	20·6
Cuddalore	22·8	Balacheruvu ..	23·0
Mulapeta	17·2	Sevandakolam ..	14·4
Markanam	19·8		

Two samples of salt contained—

Sodium chloride 91·0%, potassium chloride 3·7%.

Sodium chloride 89·7%, potassium chloride 7·2%.

(2) *Subsoil Brine.*—Attempts have been made since 1934 by the Pioneer Magnesia Works Ltd. to manufacture potassium chloride from the bitterns obtained after the separation of salt from Kharaghoda brine.

The problem of the recovery of potassium chloride was investigated by the late Mr. G. V. Sulibhavi, working in the Royal Institute of Science for the Department of Industries, Bombay. He studied the conditions of separation of carnallite from these bitterns and worked out a process for separation similar to that used in making potassium chloride from Dead Sea brine (*vide* 'A Store House of Chemicals' by M. A. Novomeysky, 1936, Institute of Chemical Engineers, London); two grades of salt being obtained, 60–65% potassium chloride and 80–85% potassium chloride. About 15 tons of 80% potassium chloride were prepared by Mr. Sulibhavi during the course of his experiments. The Pioneer Magnesia Works Ltd. have already commenced the manufacture of this important chemical and it is anticipated that about 400 tons of potassium chloride of this quality will be available annually from this source.

(3) *Saltpetre Manufacture and By-products.*—An important source of potassium salts in India is the natural occurrence of potassium nitrate in surface soils and efflorescences in many parts of the country.

The manufacture of saltpetre from this source is a very old Indian industry and, before 1860, India was the only country which supplied saltpetre to the world markets.

Large quantities of the salt are found in the United Provinces, Bihar and the Punjab and smaller quantities in Kashmir, the Central Provinces, Bombay and Madras Presidencies and in Burma. It occurs in the surface soil and can be scraped off from November to the commencement of monsoon. The average saltpetre content of these deposits is 3–5%. A full account of them is given by D. Hooper (*Agric. Ledger*, 1905, 12, 23), J. W. Leather, J. N. Mukherjee (*Agric. Res. Inst. Pusa Bull.*, 1911, 24), C. M. Hutchinson (*ibid.*, 1917, 68) and in 'The Salt Industry in India' by S. C. Aggarwal, 1937, Government of India Press.

Details of potassium nitrate manufacture will not be given in this paper but attention is drawn to the considerable quantities of potassium chloride and, to a less degree, of potassium sulphate which may be obtained as a by-product of this industry.

When the crude saltpetre is received at the refineries from the districts, it is treated with water in a pan and the liquor is brought to the boil. The liquor is run off and leaves a residue which is called 'sitta' and is taxable at Re.0-1-3 per maund. The analyses given below show that this substance has a very variable composition depending on the competence of the refinery making it, but in all cases it contains a high percentage of potassium chloride and sodium chloride :—

TABLE IV.

Sitta.

	%	%	%	%
Insoluble	4·75	16·34	2·20	2·16
Calcium sulphate	1·62	2·21	1·10	0·75
Potassium sulphate ..	12·15	..	..	2·15
Potassium nitrate	12·13	8·08	..	5·05
Potassium chloride ..	37·30	23·57	18·0	37·23
Sodium chloride	32·07	43·96	58·51	43·83
Moisture	..	3·99	2·83	6·66
Magnesium sulphate ..	..	1·39	..	1·88
Sodium sulphate	..	0·44	17·19	..
Sodium carbonate ..	..	0·07	..	0·15
Sodium bicarbonate ..	..	0·14	..	0·23

When potassium chloride is separated from sitta, sodium chloride also crystallises out and is called 'refinery salt' and is taxable at the rate of ten annas per maund. 'Papri' (analysis below) is a by-product of this separation.

TABLE V.

Papri.

	%
Moisture	0·51
Insoluble	0·86
Calcium sulphate	0·61
Potassium nitrate	4·04
Potassium chloride	18·51
Sodium chloride	49·72
Sodium sulphate	25·63
Sodium carbonate	0·15
Sodium bicarbonate	0·04

The qualities of potassium chloride obtained in this way are indicated by the analyses in Table VI. It is used largely as a manure.

TABLE VI.

Potassium Chloride.

	%	%	%	%	%
Moisture	1·75	1·14	2·50	5·30	2·18
Insoluble	9·50	1·86	3·40	0·20	0·24
Sodium carbonate ..	0·38	0·28	..	..	..
Sodium bicarbonate ..	0·48	0·19	..	..	..
Calcium sulphate	5·52	0·94	2·38	..	..
Magnesium sulphate ..	1·53	2·09	..	..	..
Potassium sulphate ..	19·15	10·74	..	..	..
Potassium nitrate	0·67	0·48	..	..	..
Potassium chloride ..	49·08	62·13	58·26	86·16	93·54
Sodium chloride	11·19	20·32	32·75	2·42	3·28
Sodium sulphate	..	..	0·43	5·84	0·46

The all-India figures are not readily available, but the authors are indebted to the Collector, Central Excises and Salt, North-Western India, for the following information relating to the West Central Division in which there were sixty-six saltpetre refineries operating in the year 1940-41. They produced 272,416 maunds of refined saltpetre containing 90% potassium nitrate, or better, and about 300,000 maunds of sitta, papri and potassuim chloride. Excluding the third analysis of sitta, an inferior specimen, it is fair to say that the content of potassium chloride does not average less than 33%. Hence, in the West Central Division of North-Western India alone, potassium chloride in sitta is available to the extent of one lakh maunds or nearly 3,500 tons. Considering the extent of the saltpetre industry in India, the figures for the whole country must be very much greater.

Even if the three sources mentioned above were fully exploited, the amount of the potassium chloride produced would probably not meet the total demand of the country. It is expedient, therefore, that attempts should be made to investigate the possibility of manufacturing potassium chloride from other Indian sources on an economic basis and it is hoped that those engaged on this important work will shortly be able to give India the benefit of their enquiries.