

MANUFACTURE OF MAGNESIUM CHLORIDE AND OTHER ALLIED
PRODUCTS AT KHARAGHODA BY THE PIONEER
MAGNESIA WORKS, LTD.

*By B. S. LALKAKA, B.A., Managing Director, The Pioneer Magnesia
Works, Ltd., Fort, Bombay.*

(Read at Symposium, April 19, 1941.)

'Bitterns' is a term applied to the residual mother liquors left in the salt pans after sodium chloride (common salt) is formed. This is generally found in the ratio of 1 to 12 at Kharaghoda where the manufacture of salt on a large scale is carried on under the control and supervision of the Salt Department of the Central Government. The mode of manufacture at Kharaghoda differs considerably from the method in vogue at other places in India and elsewhere, where ordinary sea water is used. Kharaghoda forms part of the Runn of Cutch, and is only twenty miles away from the important Railway junction of Viramgam with which it is connected by a broad and metre gauge line of the Bombay, Baroda and Central India Railway Company.

The Pritchard Salt Works of Government at Kharaghoda were first opened about 75 years ago and are now giving an average annual production of about 30 to 40 lakhs of Bengal maunds of what is known as 'Badagra' salt. The whole of this area is practically a sandy desert extending right up to the borders of Sind, and was probably submerged in bygone ages, and the sea has now receded to the Gulf of Cutch situated about 60 miles away from Kharaghoda Agurs.

Salt manufacture begins at Kharaghoda soon after the rains, when the brine with which the sandy soil is saturated is raised from shallow wells and filled into salt pans to a depth of nine inches to a foot and is allowed to evaporate for a period of from six to eight weeks. Thin incrustations of salt are formed at the bottom and the floating bitterns, or waste mother liquor, is then drained off into separate channels known as 'farans'. Fresh brine is then slowly added until actual salt cubes are formed and are ready for extraction and storage to the Central Government Stores by April. The Salt Works, which are divided into a number of 'sidings', are served by a net-work of railway lines and are a regular hive of industry during each working season giving employment to several thousand labourers. Several engines, each drawing a load of 40 to 50 wagons laden with salt ply from sunrise to sunset until all the salt is removed from the Agurs and stored in the closed and open Government stores near the Railway station some few miles from the Runn. The rainfall averages only about 20 inches annually but this is sufficient to flood the low-lying Agur area in the monsoon. During the summer months the sun is very

hot, the day temperature rising up to 120°F. and dust storms are frequent, but the cold weather is healthy and bracing.

The 'bitterns' which are drawn off to the extent of several thousand tons annually during the salt season are extremely rich in magnesia salts, and are largely utilised for the manufacture of magnesium chloride. This is an indispensable ingredient of daily use in the sizing of yarns in textile mills and is also largely required for mixing with magnesite for purposes of jointless flooring composition as well as for the manufacture of magnesium carbonate, calcium chloride, 85% magnesia (for boiler coverings) and other important uses.

The 'bitterns' left in the pans after the manufacture of common salt from sea water contain several important salts, but, as the following analyses will show, there is a greater concentration of both common salt and magnesium chloride contents in the land bitterns and brines derived from the Runn of Cutch as compared with direct sea water. It may be mentioned, however, that the brines vary considerably in composition even in adjacent wells and the figures given in the following table are only the averages of a few samples analysed at the Government Laboratory, London, on behalf of the Director of Industries, Bombay. The figures for sea water are based on the well-known analyses of Dittmar.

Composition of the Kharaghoda brines and those derived from sea water.

	Kharaghoda brines.	Sea water.
	Per cent.	Per cent.
Sodium chloride (NaCl)	14.67	2.72
Magnesium chloride (MgCl ₂)	4.63	0.33
Magnesium sulphate (MgSO ₄)	0.48	0.22
Calcium sulphate (CaSO ₄)	0.44	0.13
Potassium chloride (KCl)	0.41	0.07
Calcium carbonate (CaCO ₃)	0.01	0.01
Magnesium bromide (MgBr ₂)	0.07	0.01

'Bitterns' contain all the above salts except the calcium sulphate, and recently efforts have been made to utilise them to best advantage. At the end of each season they are usually washed away by the rain.

Magnesium chloride, magnesium sulphate (Epsom salt), potassium chloride and bromine are all substances of great commercial value, and the quantities annually wasted in India have been roughly estimated by Watson and Mackenzie Wallis as follows:—

Amount of salts wasted annually in Indian 'bitterns'.

	Tons.
Magnesium chloride (MgCl ₂ ·6H ₂ O)	1,93,000
Magnesium sulphate or Epsom salts (MgSO ₄ ·7H ₂ O)	1,27,000
Potassium chloride (KCl)	20,000
Bromine (Br)	1,800

MAGNESIUM CHLORIDE.

Before the last World War magnesium chloride was practically a German monopoly, Indian supplies being almost wholly imported from Germany at a very low price of Rs.3 to 4 per cwt. At Stassfurt in Germany there are large deposits of the mineral known as carnallite, which is a double compound of potassium and magnesium salts with traces of bromides and iodides. Magnesium chloride forms the greater portion of this carnallite and has to be eliminated before recovery of the potassium bromides and iodides, so that it could be advantageously exported as a by-product at comparatively little cost, especially when it could also be shipped as bottom cargo at low freight rates.

Magnesium chloride is one of the five most important ingredients used in size mixing. All grey yarns before passing into the loom-shed require to be sized to an extent varying with the nature of the cloth to be woven and according to prevailing climatic conditions, but in order to keep the thread pliable and soft and to enable it to withstand the strain involved in the process of weaving, a certain amount of size must always be needed.

The following are the most important sizing substances in use:—

- (a) Adhesive or starchy ingredients, like wheat flour, maize starch, or farina ;
- (b) Weight-giving products, like China clay and French chalk ;
- (c) Fatty or softening substances, like oils, beef and mutton tallow, glycerine, soap, etc. ;
- (d) Zinc chloride, to prevent mildew or fungus growths ; and
- (e) Deliquescent agents, like magnesium or calcium chloride for keeping the thread pliable and soft. Magnesium chloride, being highly hygroscopic, is peculiarly suitable as a sizing material.

At Ahmedabad, where the climate is for the most part very dry and hot and much heavier sized cloth is woven, there is naturally a greater consumption of magnesium chloride than in Bombay, where the climate is humid and the cloth is finer than that made at Ahmedabad. The consumption usually varies from about 5 tons per 100 looms per annum in Ahmedabad to about half that quantity in Bombay and elsewhere according to climate and the size percentage given and whether there is night-shifts working or otherwise.

Taking the total number of looms in India at about 200,000 and estimating about $3\frac{1}{4}$ tons per 100 looms per annum as the average mean consumption, the annual requirements of the country for textiles alone may be roughly about 7,000 tons. These were practically wholly supplied from Germany before the last World War. But as soon as hostilities started and supplies were gradually cut off, a stimulus was given to the investigation of local resources and attention was drawn to the almost unlimited supply of 'bitterns' at Kharaghoda running to waste from year to year, with the result that experiments were conducted to test the possibility of turning out a good substitute for the German article.

MANUFACTURE OF MAGNESIUM CHLORIDE IN INDIA.

Tenders were invited by the Government of Bombay for the right to remove the 'bitterns' from the Pritchard Salt Works at Kharaghoda for the manufacture of magnesium chloride and other products, and Mr. P. V. Mehd, M.A., B.Sc., who was then working as an Assistant Professor of Chemistry at St. Xavier's College, obtained the first contract for the extraction and removal of the 'bitterns' for the year 1915 on payment of 8 annas per cwt. as royalty to Government. Fresh tenders were subsequently invited for a further one year's period and a private firm under the name of the Pioneer Magnesia Works in partnership with the Hon'ble Sardar Sir Rustom Jehangir Vakil, mill-owner and merchant of Ahmedabad and Messrs. P. V. Mehd and B. S. Lalkaka took up the manufacture on payment of Government royalty which was then fixed at Rs.1-8-0 per cwt.

As the first contracts were only given from year to year, it was not possible at the outset to work on a large or a permanent scale, and during the first years the crude 'bitterns' were railed from Kharaghoda to Ahmedabad, a distance of about 60 miles, and further treated there in a rough way for the use of the mills. Subsequently, however, the factory was removed to Kharaghoda where, however, on the grant of a long-term agreement from the Government it has been working successfully for the last 25 years or so.

The factory covers a very large area of several thousand yards leased from Government on which are situated their main plant and buildings, as well as officers' bungalows and workmen's chawls, drum-making plant and store houses, etc. and for the stacking of many thousand drums annually made, and big reservoirs paved and cemented are also constructed to hold a large supply at hand of the raw material and for other work. A stock of several thousand drums of the finished product is always maintained to meet the demand. The plant was first designed in consultation with the Principal of the Victoria Jubilee Technical Institute, Bombay, and subsequently it was thoroughly overhauled and re-designed as per valuable advice and guidance received from Mr. Kapilram H. Vakil, M.Sc.Tech. (Manc.), F.I.C., M.I.Chem.E., the well-known Chemical Engineer and Technologist. Mr. Fakirji E. Bharucha, L.M.E., M.I.Mech.E. (Lond.), M.I.E., Consulting Engineer, also tendered useful advice as regards fuel problems.

OPERATIONS AT KHARAGHODA.

The first stage of operations at Kharaghoda is the collection of 'bitterns' at the source and their transport and collection at the factory. As the 'bitterns' concentrate further in the reservoirs their collection is carried out considerably in advance of their utilisation at the factory. Even at a density of 48°T. the 'bitterns' still contain some common salt, and the manufacturing operations are designed to eliminate this and other salts, as well as suspended clay and like impurities. The latter settle down in the reservoirs along with

the common salt, and the resulting liquor rich in magnesium chloride is then pumped into a series of copper pans placed over furnaces and heated to the requisite density by means of concentrated fire and the flue gases until it is finally recovered and poured into drums where it quickly solidifies and is ready for removal.

Analysis made on various occasions by competent chemists, both here and in Europe, would show that the Indian magnesium chloride is equal in quality and strength and colour to the best obtainable anywhere, and in price also it compares very favourably with any imported article and it has succeeded in ousting the foreign material to a very great extent.

Besides capturing the bulk of the Indian market, the Pioneer Magnesia Works, Ltd. have succeeded in popularising their magnesium chloride in Great Britain and in other parts of Europe and Australia where before the present war considerable quantities used to be shipped, but which are now practically stopped owing to hostilities and want of shipping.

OTHER MANUFACTURE.

The Pioneer Magnesia Works, Ltd. also owned another big chemical plant at Mithapur near Okha Port in Kathiawar for the production of magnesium chloride and other by-products including Epsom and potash salts. But subsequently with the opening of the Tata Chemicals, Ltd. there on a large scale for the production of soda ash and a dozen other allied chemical products, the company's activities are now confined only to Kharaghoda.

Amongst the other important products manufactured at Kharaghoda besides magnesium chloride on a large scale, may be mentioned table salt, magnesium sulphate, magnesium carbonate, 85% magnesia for boiler covering and lagging, and calcium chloride, potassium chloride and bromine. The company has spared no effort nor stinted money in carrying on the necessary research at a cost of thousands of rupees and they have always freely supported and endowed research scholarships whenever any suitable opportunity occurred.