Problems of Salt Manufacture in the Runn of Kutch and Remodelling of Kharaghoda Salt Works

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The problems of salt industry in Runn area are tapping sub-soil brine economically, selection of suitable sites for laying salt works, modification of present process of manufacture of salt and recovery of byproducts from bitterns. A detailed discussion on these aspects has been given in this article. Remodelling of Kharaghoda salt works has become essential for increasing the rate of production, reducing considerably internal transportation of salt and collection and processing of bitterns at a central place, economically.

The history of salt manufacture in the Runn area dates since several centuries in the past. Kharaghoda Salt Works has been manufacturing salt, on large scale, for about a century. Within past 15-20 years several salt works, both licensed and unlicensed, have sprung up all along the coastal region of the ‘Little Runn of Kutch’. The ‘Greater Runn of Kutch’ has still remained unexploited mainly for lack of any transport facilities. The location, alignment of the salt works and the method of production, system of collection and storage of salt have been the same, for all the salt works, small or big, as has been followed since the beginning at Kharaghoda Salt Works. In spite of spread over of about 9000 sq. miles of the Little Runn of Kutch, availability of concentrated brine and favourable climatic conditions for salt manufacture prevailing in this region, the development of salt industry has been haphazard for various reasons. The sea salt manufacture on the coastal areas of Saurashtra is the largest competitor for the inland salt in the Runn of Kutch due to greater purity, whiteness, low production cost and better and cheaper facility for transport. The haphazard growth of salt works, disadvantageous locations, antique system of salt manufacture followed, low yield of salt per unit area, high cost involved in obtaining brine and poor and costly transport facilities available for removing salt from the salt works to the rail-head have been responsible for the present state of salt industry in the Runn of Kutch.

The total acreage licensed till 1964-65 for the manufacture of salt in the Runn area is 15,510 acres of which 4817 acres 28 gunthas is under cultivation. The total production of salt during last 3 years by salt works in the Runn is given below:

<table>
<thead>
<tr>
<th>Year</th>
<th>Licensed works</th>
<th>Unlicensed works</th>
</tr>
</thead>
<tbody>
<tr>
<td>1962</td>
<td>646-73</td>
<td>99-95</td>
</tr>
<tr>
<td>1963</td>
<td>719-44</td>
<td>45-00</td>
</tr>
<tr>
<td>1964</td>
<td>696-94</td>
<td>60-00</td>
</tr>
</tbody>
</table>

The salt manufactured comprises of regular shaped hard crystals and is locally known as ‘Baragra’ quality. The average analysis of this salt is as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium chloride</td>
<td>96-00</td>
</tr>
<tr>
<td>Calcium sulphate</td>
<td>1-37</td>
</tr>
<tr>
<td>Magnesium sulphate</td>
<td>0-56</td>
</tr>
<tr>
<td>Magnesium chloride</td>
<td>1-48</td>
</tr>
<tr>
<td>Insolubles</td>
<td>0-19</td>
</tr>
<tr>
<td>Undetermined</td>
<td>0-40</td>
</tr>
</tbody>
</table>
Problems of inland salt works

The problems of salt industry in Runn area are quite peculiar and may be summarized broadly as follows:
1. Tapping subsoil brine economically,
2. Selection of suitable sites, layout of salt works,
3. Modification of the process for manufacture of salt, and
4. Recovery of byproducts from bitterns.

In the following paras, discussion has been made on these aspects and remedial measures suggested for making salt manufacture economical in the Runn of Kutch.

1. Tapping of subsoil brine economically

This problem of tapping subsoil brine economically is most complicated, at the same time important, on which depends the economy of salt manufacture in the Runn of Kutch. The magnitude of the problem can easily be understood from the fact that about 50 per cent of the cost of production is involved in acquiring the brine and getting it to the condenser, which includes the expenses on digging and casing the wells, on 'Kosh' and 'Bullocks', for cleaning supply channel and towards wages to the 'Sathies' (helper) employed for drawing the brine. Any reduction in the price cost of acquiring the brine will make manufacture of salt correspondingly cheaper.

To understand this point more clearly a brief discussion on the nature of Runn and the endeavours so far made to find out the solution to this major problem has been furnished below.

The geology of Runn consists essentially of alternate layers of silt, clay, sand, etc. The various formations are not uniformly distributed throughout the Runn and are mostly lenticular and patchy in character. The brine strata is usually found at a depth of 20-30 feet in the sandy strata. The supply of subsoil brine is eccentric with no assurance either about the availability of brine or the period for which it may be made available. Normally brine of the density 16-19°Be. is struck, though at a few places weak brine of 6.9°Be. concentration is also struck, near the sweet water sources.

According to Dr B. C. Roy, Superintendent Geologist, Geological Survey of India, who visited Kharaghoda in 1943 construction of percolation canals and subterranean perforated pipes will not be feasible and economical in view of marked irregularities of brine horizon, and, the most efficient and economical proposition for improving the method would eventually be sinking of hand-operated tube-wells, with provision for some mechanization in case of good yielding ones and construction of permanent wells throughout the salt works. He recommended sinking of 12 tube-wells and 12 permanent wells in the first instance, the behaviour of these to be watched over a period of several years before launching any programme of large-scale operations.

Sari S.R. Oza also carried out independent experimentation on digging bore wells at Na'nak-Nagar (Kuda). He found the average rate of percolation not exceeding 3 gallons sq. foot per hour. His observation was that up to 50 gallons per minute could be drawn from each bore well from a 2 in. tube.

The Salt Expert Committee also examined this aspect and recommended the replacement of present types of wells by tube-wells in stages over a period of 5 years and pump the subsoil brine by mobile pumps driven by electricity.

It is now suggested that the following studies may be taken up in greater details.

Casing wells

Presently for tapping brine, which is found at 20-30 ft depth, the wells dug are cased with bamboo-casings. As the entire Runn...
gets submerged with rain and sea water during monsoon season and due to peculiar nature of the soil-strata, the wells collapse and are required to be cleaned every year after the monsoon is over. Also bamboo-casing is a very poor device but is carried out being the cheapest way of casing the wells. The average life of well in this way is for about 4 years. Certain wells which have been case with planks have stood for several years and are yielding good supply of brine continuously. Thus the studies are required to be made for economically casing the wells by devising suitable methods and materials to be used for casing. Provision has to be made to recover the material if the well fails, and its economical utilisation, so that even when costly material is used for casing, its effective life is made spread over to several years. It is proposed that casing of wells with suitable well-seasoned planks be experimented on large scale. It is hoped that by doing so plenty of wasteful labour and material (bamboo casings) will be saved and plentiful brine for longer duration will be available from the same sources (wells).

Though so far no systematic studies have been made for tapping brine at still lower strata, however with whatever work has been done so far in this respect, it appears that much hope cannot be laid on acquiring saturated brine of such concentration and in plentiful, at still lower strata. Further work to prove whether the above assumption is correct is required to be carried out by sinking a few bore wells, at selected sites.

Percolation studies

The percolation of brine in different regions is not uniform. It is worth while studying the rate of percolation of brine in different regions over a longer duration, so as to plan the fruitful life of the well etc., and also the quantity of brine which may be expected from the various regions.

Method for tapping brine

Depending upon the ‘drawing rate’, i.e. the quantity of brine which can be drawn regularly without harming in anyway the strata of sand or soil, the mechanical means for lifting brine can be worked out. As the rate of percolation is slow, it is not expected that continuous pumping will be possible, but working with mobile pumps to a battery of properly cased wells dug in the proven fruitful areas, can obviously solve this difficult problem for the present. With least doubt, economically this method will drastically cut down the cost of manufacture of salt in Runn area. In the present circumstances, no better proposition than the one suggested above appears to be more suited. In long run, if tapping of brine by other means such as with tube wells is found to be more economical, the process can be changed over, accordingly.

2. Selection of suitable site and layout of salt works

There are two aspects for the salt industry, (i) manufacture of salt, and (ii) transportation of salt to the stores from where it can be despatched by rail/sea/road. For the manufacture of salt economically, the problem of brine supply is the major factor and general discussion on this aspect has been made earlier. The layout of salt works in Runn area with special reference to realignment of Kharaghoda Salt Works is discussed below:

For any industry, the flow of liquid is considered the cheapest and quick mode of conveyance than solids. Why this practice is not followed in case of salt works in the Runn? Why the brine from its sources in the interior of the Runn is not flown to the banks of the Runn (Kanthas), where the rail and other transportation facilities can be arranged in a better way? By locating the salt works on the firm land on the banks of...
the Runn, the advantages will be, (a) no time-lag in starting the manufacturing operation for salt manufacture, (b) quick and cheap supply of daily necessity things to the agarias, (c) can cause establishment of salt based chemical industries, (d) cheap transportation and loading of salt into wagons, (e) possibility of systematic and complete recovery of byproducts close to the salt works, and (f) extension of salt manufacturing season up to almost the day of heavy rains. These advantages are not availed of in locating the salt works in the interior of the Runn. The only advantage of locating the salt works in the Runn is that the present concept of locating the crystallizers as close to the source of brine as possible is being followed. In addition to the above, by locating the condensers and crystallizer beds on the banks of Runn it will be possible to have uniform grade of salt, and to mechanise various operations in the manufacture and handling of salt. By doing so the process presently adopted will also require certain modifications. In this case the wells may be dug systematically in the area proven yielding plentiful of concentrated brine. The brine may be lifted with pumps mounted on a trolley and flown through the common channel to the common reservoir. After getting the brine saturated in respect with sodium chloride it is charged into the crystallizers laid down in series.

The modified system of salt works will involve good deal of capital investment for common services like purchase of pumping sets, opening common channels which may be of few miles length and a strong bund for encircling the entire area of condensers, crystallizers, mixed salt area, stores, etc., for which it will be essential to plan for the minimum production. It is considered that for remodelling of salt works, a minimum production of one lakh tonnes be aimed at and suitable areas for the crystallizers as well as plentiful area for digging wells or tube wells be reserved, for making salt manufacture economical.

Keeping in view the above considerations, the general realignment plan of the salt works at Kharaghoda has been prepared which is enclosed herewith (Sketch I). The Kharaghoda salt works has the capacity of 6,31,000 M.T. of salt. The various considerations made for remodelling the Kharaghoda salt works are described below in brief.

The layout of salt works consists in laying the condenser area in the direction of breeze, followed by the crystallizers in 8 rows so that the flying dust particles may settle in the condenser area. The stores and the mixed salt pans are then laid out, very close to the rail-head, water and electric supply points, so that the salt may be loaded straight from the stores, and setting up of the recovery plant for byproducts may become possible in this area and the cost on transportation of bitterns or mixed salts over a longer distance is saved.

It is expected that brine of average density of 16-17°Bé. will be available from the wells, which will rise to 19°Bé. while flowing in the open channel. The size of the condenser has been maintained half the size of crystallizers based on theoretical calculations, whereby it will be possible for the brine of 19°Bé. to concentrate to 24°Bé. The area of the condenser may be further sub-divided for circulating the brine. Similarly the condensers may be partitioned if brine of varying compositions has to be processed separately. Enclave type of construction for few sets of condensers is proposed to store the concentrated brine available on the onset of monsoons.

Construction of strong bund all around the salt works will be advantageous in (i) saving the cost of repairs for condenser, pathways, feeding and discharge channels, crystallizers, and mixed salt area, (ii) enhancing the
manufacturing season, by permitting early start of salt manufacturing season and continuing the operations till the date of heavy rainfall by suitably modifying the system of salt manufacture, and (iii) enabling transportation of salt even during monsoon months, if needed.

288 crystallizers are proposed of the size of $188 \times 39$ metres ($600 \times 125$ ft) each with a provision to enlarge the size of pans, when heavy mechanical harvestors will be required to be employed. A gradual slope of 3 in. (depth of pan 13-16 in.) has been maintained with a view to discharge the bitterns effectively. The mud removed from the pan will be utilized to raise the height of the in-between platforms, thereby permitting deep charging of brine to the extent of 18 in.

Along the sides of two rows of the crystallizers, the feeding channels to the maximum depth of pans are provided, while in the middle the discharge channel for bitterns has been proposed with the minimum depth of pan so that the bitterns may not get percolated either in the feeding channels or in the crystallizers.

Suitable space has been reserved for storing salt on little elevated space.

One-fifth area of the crystallizers has been allotted for the recovery of crude salt and mixed salts. Provision has been made for labour quarters, factory shed, storage for mixed salts, etc., in the area marked for the mixed salt.

The batteries of wells are proposed to be dug at equidistance of 100 ft with a provision of suitable road so that one pump-set mounted on trolley with pneumative tyres may work for 30-40 wells, depending on their yield.

The common channel may be given a small slope, so that the brine can flow easily. To avoid any percolation, the channel may be lined with polythene sheet either laid on this surface of the channel or fixed on the wooden frame to keep in the correct position.

At the end of the channel, a pump of suitable capacity may be established for lifting the brine. The condensers are not required to be dug, but bunded so that sufficient head may be created for flowing brine with gravity all along with feeding channels.

3. Modification of process of salt manufacture

The preparation of pan-bed is very important operation and has to be done with great care. The system of giving 'Kharwar' (charging concentrated brine into the pan) and permitting small dirty crystals in the pans before charging the saturated brine for the first time is responsible for dullness of the crystals.

Multiple accretion system of salt manufacture with single crop in a manufacturing season is undoubtedly the noble method investigated by the local salt manufacturers but as considerable period is required for ridging, heaping and transportation of salt to stores, towards the end, which is the most fruitful period of salt manufacture, this system of salt manufacture will require to be changed over to harvesting more than one crop in the season, so as to spread over the storage period for longer duration. The hardness of the crystals in the Runn is on account of presence of high percentage of manganese (7-21 p.p.m.) present in the concentrated subsoil brine and by extracting salt crop more than once in the season, except for the size of the salt crystal, other factors of hardness and its uniformity will be the same. Again, presently, the demand for salt from the alkali industry is increasing greatly, where salt is used in the form of brine solution. For industrial consumption grain size of the crystal is immaterial, in fact smaller grain size with quick dissolution rate will be more desirable. For consumption for alkali industries and
for similar such uses where grain size is not important factor, manufacturing of 'Kurkutch' system of salt manufacture by harvesting two or three crops will be greatly advantageous in spreading over the storage period. However, depending upon demand, the production of 'Baragra' quality of salt may also be produced.

Due to low percentage of SO_2 in the sub-soil brine the solubility of gypsum is suppressed and the separation of gypsum instead of starting from 17°Bé or so, as is the case with sea brine, is delayed up to 20°Bé or so in case of sub-soil brine. This causes large percentage of contamination of gypsum with the salt precipitating between a range of 25-26°Bé. Almost 2/3 quantity of salt separates out in this range. However, remaining quantity precipitating after 26°Bé is containing comparatively lower percentage of gypsum and is acceptable to the chemical industries. The second fraction contains higher percentage of magnesium salts, which can be washed with saturated brine before harvesting the crop from the pans. For obvious reasons for meeting the varied demand of salt, manufacture of more than one variety of salt do not require any change in layout of the salt works.

4. Recovery of byproducts from bitterns

Collection of bitterns at a central place and its processing for the recovery of valuable byproduct have not been done by any of the inland salt works, except at Kharagoda, where a small percentage of bitterns available is processed for the recovery of some of the byproducts. Presently, it is a problem to collect bitterns economically due to the crystallizer pans scattered over a long distance. Realignment of salt works as suggested above will solve this problem and make the bitterns available at a central point. Whatever bittern is available towards the end of manufacturing season can also be stored and processed subsequently in the proposed layout in this area of scanty rainfall. This Institute has done pioneering work on the recovery of valuable byproducts from the bitterns. Recovery of byproducts will lead to reducing the cost of salt production, by crediting the cost of bitterns supplied which otherwise are wasted.

5. Mechanization

Internal transportation of salt from the crystallizer to the storage yard will be done economically by laying rails of 2 or 2½ ft gauge and hauling salt with the tipping wagons with locomotives. This will assure quick and cheap transportation, for which provision has been made in the layout of the salt works. Till the harvesting of salt is mechanized, the trolley tracks may be laid out on either side of the pans to cut down the lead for loading salt in the wagons. Broad gauge lines for one or two sidings may help in handling the salt quickly in case of emergency and for direct loading of salt from the pans.

Mechanization of major salt works is absolutely essential. Varied operations like lifting brine, raking, spading, tamping, puddling, conveying, harvesting, storing, destoring, etc., may be mechanized both for improving the quality of salt and making salt manufacture economical. In a remodelled salt work, the system of salt manufacture will not be as is presently followed, where each 'agaria' has to carry out all manufacturing operation individually. On the other hand, the entire preliminary operation, lifting of brine, digging wells, constructing common-feeding and bittern channels, main bunds, etc., have to be done by the salt manufacturers (licenser) under his own supervision and with a view to economize expenses on these items. Mechanization of
these operations as far as possible will go a long way in making the salt manufacture economical in this region. There appears to be no fear of heavy retrenchment from the salt industry in this area, by mechanization of the various operation. On the other hand the anticipation may be that the production of salt in Runn area will increase in a planned way and well established salt works will be in a better position to make better payment to the 'agarias'. Again, recovery of by-products will provide more and more employment to the workers and the Runn area will open new vistas for industrialization of this area for the betterment of economy of this region.

References
2. Aggarwal, S. C., Salt Industry in India (Manager, Publications, Government of India, Delhi) 1956, 244