International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 04 Issue: 05 | May -2020 ISSN: 2582-3930

Lacunas in existing Enviro legal frame work related to Brine sludge management in chlor- alkali sector

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Abstract –
Chlor-alkali sector is a significant contributor of environmental impacts owing to its high energy consumption, large quantity of solid waste generation and hazardous emissions. Although the custodian of environmental legislation viz MoEFCC, CPCB and SPCBs have been framing standards and guidelines and enforcing the implementation of the same, these legislations often seems ineffective and do not address the challenges of chlor alkali sector in brine sludge management. Present work aims to highlight the gaps in existing environmental legislations pertaining to caustic soda plant and to suggest probable amendments.

Keywords: Chlor-alkali, Brine sludge, membrane cell, liner, Landfill, EIA.

1. Introduction:

Chlor Alkali is the term used for the industrial sector which produces caustic soda, chlorine and soda ash. Caustic Soda is the major product of Chlor Alkali Sector. There are around 30 major industrial units in India manufacturing Caustic Soda as per the database of Alkali Manufacturers Association of India (AMAI). Growth of chlor alkali sector in India is projected at the CAG rate of 8% annually.

Caustic soda is one of the important chemicals which have been contributing significantly to the growth of chemical and other allied industries. An ever increasing demand pattern for this important chemical in India is primarily due to its increasing use in major industries such as the textile, pulp & paper, aluminium, pharmaceutical, dye stuffs, soap and detergents, and fertilizers etc. to name a few.

1.1 Statistics of Chlor alkali sector in India:

Chlor-alkali sector forms around 74 % of basic chemical industries in India.
The Installed Capacity of Caustic Soda in India as on 31 March 2019 was 42.78 Lakh MTPA.
The Production of Chlorine during the year 2018-19 was 31.8 Lakh MT. During manufacturing of Caustic Soda through electrolysis process, huge amount of Chlorine and hydrogen gas is generated from the membrane cell process

2. Material And Methodology of study:

For the study of manufacturing process, site visit was conducted in 5 major caustic soda producing units located in industrial area of Bharuch district. Also, process description given by technology suppliers, data given by process owners and interaction with process experts is the basis of this study. EIA reports of more than twelve caustic soda units have been studied. References have been taken from standard literary sources of Alkali Manufacturers Association of India (AMAI) and web sources of various caustic chlorine industries.

2.1 Manufacturing Process of Caustic Soda:

Common Salt (NaCl) is the raw material for production of Caustic soda (NaOH) which is brought from salt panes and stored in silos within the site.

Caustic Soda is produced by Electrolytic Process of Sodium Chloride (Brine) using Ion-Exchange Membrane Process. This process also produces Chlorine & Hydrogen as Co-products. Modern Electrolytic process uses membrane cell technology which is sensitive to impurities hence, before electrolysis of brine solution (NaCl) it is necessary to purify the brine to the required degree to achieve high concentration. The waste generated during purification of brine solution is called as brine sludge. Purification involves following stages:

a. Brine Saturation
b. Primary Brine Purification
c. Secondary Brine Purification

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Membrane Cell Electrolysis:

Heart of the entire process is the electrolysis. After treatment in above steps, the brine meets the requirements and is fed into the anode chamber of electrolyser cells.

The anode and cathode chambers of the cell are isolated from each other by membrane which is selective to the migration of sodium ions. Water to some extent also diffuses through the membrane from the anode chamber.

During Electrolysis, Chlorine gas and depleted brine is generated from anode chamber side, while a two phase mixture of 33% NaOH and Hydrogen overflows from the cathode chambers.

Reaction involved in electrolysis is as follows:

Anode Reaction : $2\ NaCl \quad 2\ Na^+ + Cl_2 + 2\ e^-$

Cathode Reaction : $2\ H_2O + 2\ e^- \quad H_2 + 2\ OH$

Overall Reaction :

$2\ NaCl + 2\ H_2O \quad 2\ NaOH + Cl_2 + H_2$

Schematic diagram of modern membrane based Electrolytic cell is depicted in fig.2.1

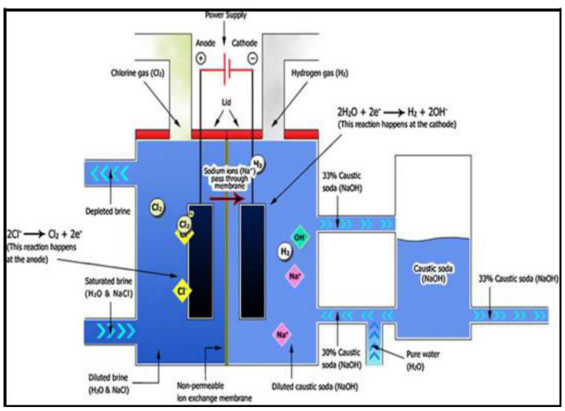

Fig: 2.1 membrane based Electrolytic cell (image courtesy-Euro Chlor)

A general Process Flow diagram showing all the stages in manufacturing process is shown in Fig.2.2

Earlier, mercury cell technology was employed for the production of Caustic soda and chlorine. The waste generated from this process contained mercury, hence was considered as hazardous waste. With the advancements and technological reforms, modern membrane cell technology took over the former technology.

2.2 Brine Sludge:

Although the brine sludge generated during purification of NaCl solution is non- hazardous, the large volume of waste still remains a challenge. As per the caustic soda

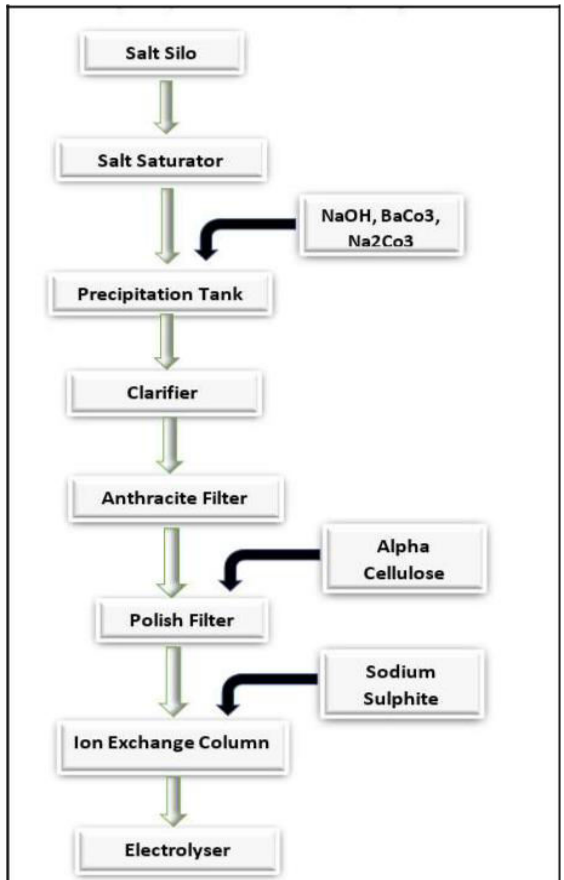

Fig.2.2 stages in Manufacturing process

industry bench mark, for the production of 1 Metric Ton of caustic soda, approx. 80 kg to 100 kg of brine sludge is generated. Scaling this up to national production capacity of caustic soda, for the production of 42 Lakh MT per annum of caustic soda, approx. 4.2 Lakh MT brine sludge is estimated per year in the country.

Further, Study of EIA Reports and process description shared by process experts reveals that, moisture content in brine sludge before disposal in landfill site is up to 45% to 55%. This is due to age old dewatering technology utilised by the industries i.e Rotating Vacuum Drum Filter (RVDF). The design removal efficiency of RVDF is 45% to 55%. Hence, large volume of brine sludge is attributed to high moisture content.

The disposal of such waste in landfill poses multiple adverse environmental impacts such as loss of valuable land and chances of ground water contamination. Also Lays economic stress on industry due to cost of land, construction and operation cost, monitoring cost, closure and post closure cares. Further, Legal liabilities of landfill owner can not be denied for entire operational and closure tenure.

3. Review of Indian Environmental Legislations related to Chlor Alkali Sector.

Since the inception of industrial revolution and industrialization, the environment has been witnessing the adverse effects due wastes generated at the end of any production process.

Governments have been thriving to control the degradation of wholesomeness of environment through various means and measures. One such measure is legislative measures.

Since, seventies decades environmental regulations are being framed by union government to prevent and control the pollution. Prominent laws/ guidelines applicable to a caustic soda and specifically brine sludge are,

1. Environment Protection act -1986 and rules thereof.
2. Hazardous and other Waste (management and transboundary rules)- 2016
3. Environment Impact Assessment Notification- 2006 and amendments.
4. Minimal National Standards (MINAS) for specific industries by CPCB
5. CP guidelines in caustic soda industries by GCPC & ENVIS

It is mandatory for the waste generating units to take appropriate measures to protect environment from probable hazard arising out due to waste generated from its operations. Also, the same is emphasized in "The polluter pays principle".

3.1 TSDF/ Landfill Construction as per CPCB Guidelines:

To ensure no contamination of ground water and soil due landfilling of not only brine sludge but any waste, CPCB has stipulated specifications for the construction of SLF facility. The same is presented as below

a. Specification for bottom liner for single composite liner:

1. Leachate collection layer of thickness 30 cm or more and co-efficient of permeability in excess of 10 -2 cm/sec (10 -4 m/sec).
2. A HDPE geomembrane of thickness 1.5 mm or more and
3. A compacted clay (or compacted amended soil) layer of thickness 150 cm or more having a coefficient of permeability of 10 -7 cm/sec (10 -9 m/sec) or less. At locations where availability of clay is limited, amended soil will be constituted by mixing bentonite or any other suitable clay to locally available soil to achieve the desired permeability.

b. Specification for top cover of landfill facility:

1. A surface layer of local top solid which supports self-sustaining vegetation and which has a thickness not less than 60 cm.
2. A drainage layer of thickness 30 cm or more having a coefficient of permeability in excess of 10 -2 cm/sec (10-4 m/sec).
3. A HDPE geomembrane of thickness 1.5 mm or more.
4. A compacted layer clay (or compacted amended soil) layer of thickness 60 cm or more having a coefficient of permeability of 10^{-7} cm/sec (10^{-9} m/sec) or less. At locations where availability of clay is limited, amended soil will be constituted by mixing bentonite or any other suitable clay to locally available soil to achieve the desired permeability.
5. A regulatory layer (optional) of thickness 30 cm having coefficient of permeability greater than 10^{-2} cm/sec (10^{-4} m/sec). Such a layer shall be provided whenever there is requirement of (i) gas collection or (ii) transition filter between waste and soil.

3.2 Environmental (Protection) Rules, 1986

Clause iv of sub section 2 of section 3 of EPA- 1986 which accords that central government has powers to lay down standards for discharge of environmental pollutants from various sources whatsoever.

Based on above provisions central government has laid down discharge norms for the pollutants emanating from wide categories of industries. In line with this, effluent discharge norms has been prescribed for caustic soda industry which reads as below:

As per Schedule-I of EP Rules, total effluent generation from chlor alkali unit should not increase 1m3/ tonne of caustic soda produced excluding cooling tower blowdown.

Similarly for cap on water consumption in caustic soda industry, limit has been specified.

For control on Air emission, norms have been assigned for HCl and Chlorine released from process vents.

However, neither any norms have been prescribed for generation quantity of brine sludge nor for its characteristics.

3.3 Environment Impact Assessment Notification- 2006 and amendments.

Environmental Impact Assessment (EIA) is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account interrelated socio-economic, cultural and human-health impacts, both beneficial and adverse. In India, Environment Impact Assessment Notification was brought into effect in 2006 vide S.O 1533 which mandates prior Environment Clearance for any project such as green field, expansion, modernization, whatsoever if the project attracts provisions of EIA Notification- 2006 and subsequent amendments.

Chlor-alkali sector falls under 4(d) category in the schedule of this notification.

However, certain gaps are observed in the "on ground execution" and application of this EIA notification in serving the very objective of EIA process i.e environment protection.

Environment Impact Assessment is carried out with an aim to get Environment Clearance (EC) and not with an objective to anticipate the probable environmental impact and suggesting the mitigation measures. Decisions are taken by authorities just based on data submitted by industries. No new technological intervention regarding brine sludge dewatering or disposal has been asked by authorities while granting the EC.

3.4 Minimal National Standards (MINAS) by CPCB:

The Minimal National Standards (MINAS) for a particular industry are the effluent standards achievable by the industry by installing pollution control measures which are within the techno-economic capability of the industry.No Industry can deny with these standards since these standards are developed after in depth techno-commercial feasibility consideration.

Talking about Caustic Soda industry, MINAS have been developed after holding in depth discussions with the Alkali Manufacturers' Association of India (AMAI).

Back in 2003, MINAS for caustic soda industry was published by CPCB which accounts for process involving mercury cell technology. Since, Mercury cell technology is phased out pan India and are not into place, MINAS for caustic soda industry stands null and void.

3.5 CP guidelines in caustic soda industries by GCPC & ENVIS:

Cleaner production guidelines are recommendations by Gujarat cleaner production centre (GCPC) and backed with ENVIS (Environmental Information System). Various measures such as raw material substitution, Equipment modification, technology change, etc are suggested in the form of Cleaner production measures to various industrial processes. However, these guidelines are not enforceable and not regulatory in nature.

In the guideline for caustic soda industries, comparison between three different methods of caustic soda production is done i.e. comparison between Diaphragm cell process, Mercury cell process and Membrane cell process is made.

It should be noted that former two technologies are already obsolete. Also it is the fact that no new plant is built with Diaphragm cell process and mercury cell process.

In this guideline emphasis has been laid on environment friendly aspect of membrane cell process. Also this process yields improved quality of caustic soda lye.

Membrane cell process is energy intensive; approximate 65% of the production cost is attributed to high electricity consumption.

In a nut shell, the guideline is silent over generation, reduction, disposal issues, etc pertaining to the brine sludge.

RESULT AND CONCLUSION

A compendium of lacunas in environmental legislations pertaining to brine sludge is presented as below:

As a consequence of lack of any guidelines brine sludge is being dumped in hazardous waste landfill sites in continuation to the practise adopted when the brine sludge consisted mercury and was considered as hazardous.

Norms prescribed in Environment (Protection) Rules - 1986 holds no relevance with this kind of waste which is generated in tremendous quantity daily.

Minimal National Standards (MINAS) for caustic soda plant was brought into effect by CPCB in 2003 when mercury cell technology existed. Entire standard accounts for process involving mercury cell technology only. With the gradual phaseout of mercury cell technology this standard is automatically revoked.

Also, Cleaner production guidelines are silent on reduction of brine sludge or any such recommendations for which the concept of CP is in charm.

The EIA process in India carries lacunas specially in the case of chlor alkali sector. After vetting carefully the EIA reports of various Chlor alkali industries it becomes clearly evident that mostly EIA reports do not cover important points like limits for generation of brine sludge, high moisture content of sludge. No weightage is given on environmental impact due to daily disposal of such a humongous quantity of brine sludge. Yet these reports are considered by authorities and clearances are granted.

If controls are specified by authorities at the TOR (Terms of Reference) stage of EIA process, the proponents will have to modify their technology and other arrangements to achieve the limits specified in ToR in order to obtain EC. Further, Clearance can be given with specific conditions for the operation phase of the projects to impose the limits and controls regarding quantity, characteristics and moisture level in brine sludge. This fact is absent till date.

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