A STUDY ON BROMINE MARKET TREND ANALYSIS AND REGULATORY ENVIRONMENT IN INDIA.

Dissertation Submitted to-

The IIHMR University, Jaipur

For the partial fulfilment of the degree of

Master of Business Administration (MBA)

In

Pharmaceutical Management

By

Mr. Yashpal Singh Solanki

Under the supervision of-

Dr. Saurabh Banerjee

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DECLARATION

I, **YASHPAL SINGH SOLANKI** (MBA PM-13), School of Pharmaceutical Management, IIHMR University, declare that the project report titled **"A study on Bromine market trend analysis and regulatory environment in India."** prepared by me under the guidance of **Dr. SAURABH BANERJEE**, Dean & associate professor, School of pharmaceutical management, IIHMR University. I also declare that this internship work is towards the partial fulfilment of the University regulations for the award of degree of Master's in business administration, Indian Institute of Health Management Research. I further declare that this project is based on the original study undertaken by me, wholly done by me with the use of primary and second-hand information and has not been submitted to any other university for the award of a degree, diploma, or any other similar title.

Yashpal Singh Solanki

Roll No- 0359

Place: Jaipur

Date: 03/06/2023

CERTIFICATE BY GUIDE

CERTIFICATE BY COMPANY

Haartz ORGANICS PVT. LTD.

CIN U24100MH2011PTC216153

L-48, Additional MIDC Mahad Birwadi, Tal. Mahad, Dist. Raigad. Maharashtra - 402 309

E-mail : haartzorganics@gmail.com • Website : www.haartzorganics.com • Mob.: 9820169088, 9967101535 ✆ : 02145 282493

Ref.No.025/HOPL/2022-23 **Date: 31 March 2023**

Mr.Yashpal Singh Solanki

Mumbai,India

To Whom It May Concern

Subject : Intership Letter

This is to certify that **MR.YASHPAL SINGH SOLANKI,** student of MBA at IIHMR Univercity Jaipur has Undergone internship with **Haartz Organics Private Limited** from 01 March 2023 to 31 May 2023.

During the period of internship, he was worked on "Business development & Sales"and has successfully met the projectives of the intership. We found Mr.YASHPAL to be responsible,hardworking and had good communication skills.

We wish him all success in future endeavors.

HAARTZ ORGANICS PVT. LTD. Plot No. L-48 MAHAD

Haartz Organics Pvt Ltd.

Parbat Singh

Authorized Singatory

ABSTRACT

Background- This research is based on the 3-month internship program that I successfully completed at Haartz Organics private limited Raigad, Maharashtra in the domain of operations under the guidance of Mr Parbat Dahiya the Plant manager from 1st March 2023 to 31st May 2023 as part of my dissertation for my Master of Business Administration in pharmaceutical management program at Indian institute of health management research university, Jaipur. This was a unique experience for me to work in a manufacturing plant and understand the workings of the industrial environment and I was able to learn great deal from this opportunity.

Research Purpose- The purpose of this research is to understand the Bromine market global and Indian and its scope for emerging India and to understand the regulatory framework for the chemical element. We see in the report that bromine is one of a very highly demanded chemical as it has many applications apart from chemical and pharmaceutical industry it also has application in fertilizer, Biocides, Fire retardant, Bromine-based battery.

Findings- Fire retardant is one of the highest applications of the chemical by industry segmentation, one of the most upcoming and unique application being the bromine-based battery, is a type of rechargeable battery that generates electricity through the interaction of zinc metal with bromine in the presence of an electrolyte made of an aqueous solution of zinc bromide. For stationary power applications, ranging from home to grid-scale, it is being explored as a substitute for lithium-ion batteries. In comparison to lithium-ion battery systems, the water-based electrolyte makes the battery system less prone to overheating and fire.

I was also able to understand the working of Maharashtra pollution control board the PCC of Maharashtra that grants consents and licenses to industries and regulates them and it also makes sure that industries are not polluting the environment. I learned more about the process of obtaining a consent from MPCB you will find more information in the research further.

ACKNOWLEDGEMENT

It is with great satisfaction and achievement that I have completed my project. I take this opportunity to acknowledge each one who contributes to my work.

I would like to thank IIHMR University, **Dr Saurabh Banerjee, Dean, School of pharmaceutical management, IIHMR University** who gave me an opportunity to undergo this wonderful experience of SIP.

I am also thankful to him as my guide who has provided me all sorts of advice, support, and encouragement to complete this project work. I express my sincere gratitude to **Haartz Organics** for giving me an opportunity to do this **3 Months** of internship. I convey my utmost gratitude to **Mr. Parbat Dahiya**, Manager and all the staff of **Haartz Organics** who was a constant source of inspiration has always been and encouraged me with their innovative ideas and behaviours. Finally, I would like to thank my parents, friends and all those who have helped me directly and indirectly to bring out this project report.

Yashpal Singh Solanki

Roll No- 0359

MBA- PM 13

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

1. **CRM = Customer Relationship Management**
2. **CAC = Customer Acquisition Cost**
3. **MC = Marketing Costs**
4. **CA = Customers Acquired**
5. **BM= Business Management**
6. **ROI – Return on Investment**
7. **CEOs – Chief Executive Officers**
8. **Br2- Bromine**
9. **NaBr- Sodium Bromide**
10. **HBr- Hydrobromic Acid**

CHAPTER 1 – INTRODUCTION

Study purpose- The purpose of this study is to understand the market trends of bromine and its compounds in India and global scenario and to understand its regulatory environment and norms in India and the state of Maharashtra.

Research problem-

To find the answers of the following questions is the motive of this study.

- What are market and growth trends of bromine in global scenario and India?
- What is the regulatory framework for Bromine in India?

Aims and Objectives-

- To research and analyse the 2019–2029 global bromine market size (value and volume) by company, significant regions/countries, products, and application.
- To comprehend the Bromine market's structure by recognising its many subsectors.
- To provide in-depth information on the key market growth determinants (growth potential, opportunities, drivers, industry-specific risks and constraints).

- Concentrates on the major global producers of bromine, defining, describing, and analysing sales volume, value, market share, market competition environment, SWOT analysis, and future development plans.
- To examine the Bromine in terms of specific growth patterns, potential developments, and market share.
- To forecast the size and value of the bromine submarkets in relation to important geographic areas (along with those regions' important home nations).

- To assess market-wide competitive developments, such as product launches, partnerships, expansions, and acquisitions.
- To strategically assess the major players and thoroughly examine their expansion plans.
- To study the regulatory environment in India.
- To study the process of getting a approval for a manufacturing unit in Maharashtra.
- To understand the needs and necessities by the pollution control boards in India for manufacturing plant.

About the company-

Haartz Organics Private limited was established in 2013, It is the manufacturer of Liquid Bromine with the capacity to manufacture around 70 Metric tons per month. The company is situated in MIDC Mahad, Maharashtra which is 200 Kms away from Mumbai. Bromine is a highly toxic element and is used for the process of "Bromination" in Active Pharma Ingredients and to manufacture other synthetic chemicals.

Mission & Vision-

- Mission- To become one of the biggest manufacturers of bromine in India.
- Vision- To bring affordability in chemical industry while considering the environment regulations.

Products-

- Liquid Bromine Recovered (99.5%0
- N-propyl Bromide
- N-butyl Bromide
- Hydrobromic Acid (HBr) 48%
- Spent Sulfuric Acid
- Processing Sodium bromine solution

Introduction of Bromine-

Bromine (Br2) is a dark red liquid with a harsh, penetrating odour that emits dark red, extremely corrosive fumes. It is a crucial component of dyes, inorganic medicines, photosensitive substances, and medications. It is also the main component used in the creation of hydrobromic acid (HBr), which is used as a natural resource for the production of several organic intermediates and pharmaceuticals, such as lithium bromide. It can be produced from saltwater, or natural brines or brines made as a through-product of potash recovery.

The market for bromine was assessed at USD 1971.7 million in 2022 and is projected to grow to USD 2484.3 million by 2030, at a CAGR of 3.3% from 2023 to 2030. When calculating market sizes, the impact of COVID-19 and the Russia-Ukraine War were taken into account.

ICL, Albemarle, Lanxess (Chemtura Corporation), and others are major competitors in the global bromine market. A share of more than 60% is held by the top three manufacturers worldwide.

The Middle East has a market share of around 50%, followed by China and North America, each of which have a share of about 35%.

With a market share of more than 50%, Dead Sea Brine is the most significant product category. Flame Retardants are the most often used application.

Central Pollution Control Board

A statutory organisation under the Ministry of Environment, Forestry and Climate Change (Mo.E.F.C.C.), CPCB of India controls pollution. The Water (Prevention and Control of Pollution) Act of 1974 allowed for its establishment. The 1981 Air (Prevention and Control of Pollution) Act also gives the CPCB authority and responsibilities. As the technical arm of MoEFCC, Shri Tanmay Kumar is the current acting chairman till August 2021, and Dr. Prashant Gargava is the member secretary.

With seven zonal offices and five laboratories, the CPCB's headquarters are located in New Delhi. The board carries out investigations and environmental evaluations. In cooperation with zonal offices, tribal governments, and municipal governments, it is in charge of upholding national standards under a number of environmental legislations. Some of its duties of the board are doing adequate water quality testing and air pollution monitoring and quality testing they have put in effect numerous anti-pollution programmes and initiatives that help not only reduce pollution but also conservation of energy such initiatives are undertaken with the help of government and business collaboration the central government is responsible for the management of air and water pollution.

Maharashtra Pollution Control Board

In the Indian state of Maharashtra, the Maharashtra Pollution Control Board, formed on September 7, 1970, carries out a variety of environmental laws. The Maharashtra government's Environment Department has administrative jurisdiction over the MPCB.

Several of MPCB's crucial duties are;

- To create a comprehensive strategy for preventing, reducing, or eliminating pollution and ensure its implementation,
- To gather and spread knowledge on pollution and its control, avoidance, or reduction,
- increasing public awareness of a clean, healthy environment and responding to concerns from the public concerning pollution.

The process of distillation and recovery of Liquid Bromine

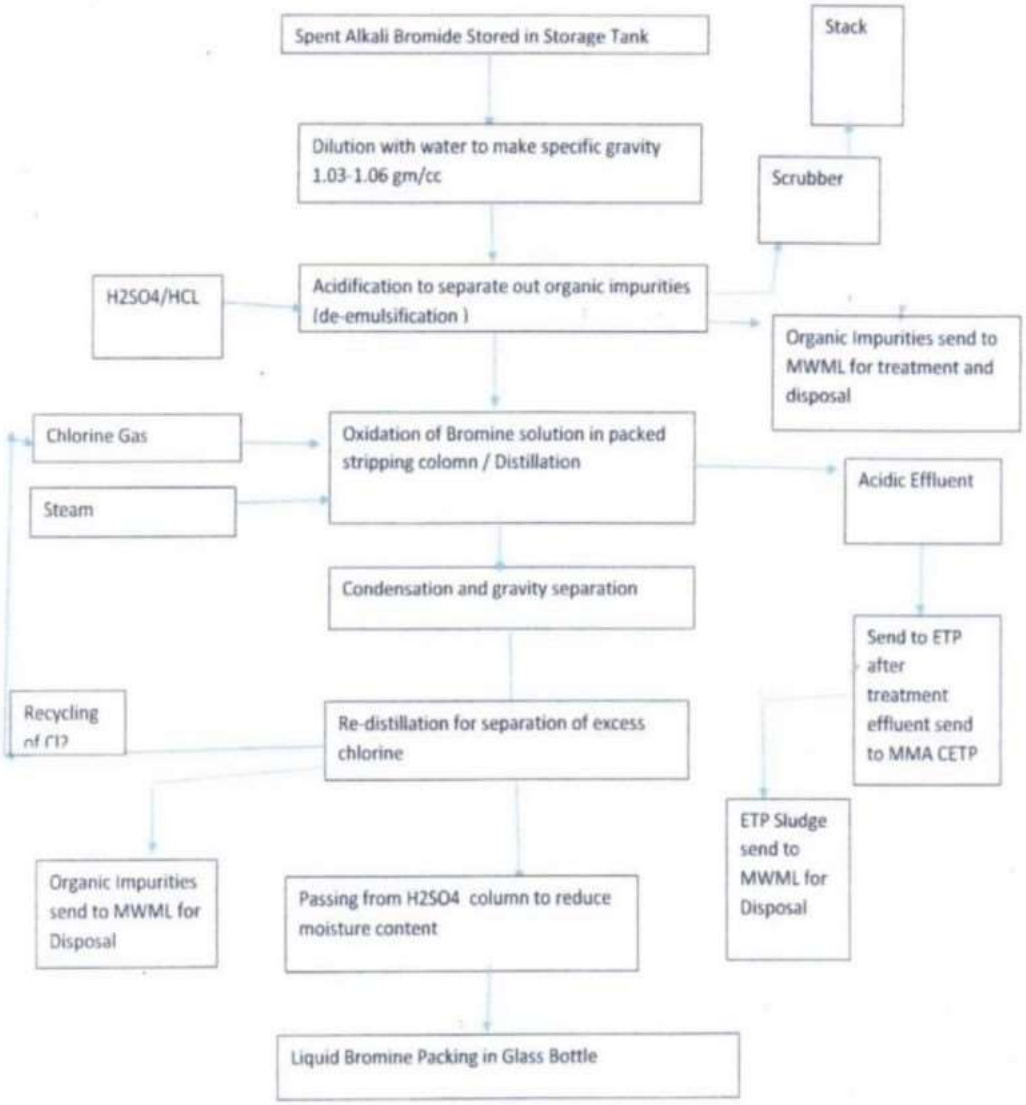


Fig 1.1

SWOT ANALYSIS

Strengths- Demand for flame retardants is rising in the textile, consumer goods, and electronics industries.

By delaying combustion and creating a layer of free radicals, brominated flame retardants keep fires at bay. Either carbon dioxide is released, or free radicals interact with oxygen molecules. thereby halting oxidation. Flame retardants are often utilised in construction materials, furniture, textiles, electronics, and other products.

Weaknesses- emergence of flame retardants without halogens.

Brominated flame retardants have been negatively impacted by potential environmental and health risks. With the introduction of stricter environmental, health, and fire restrictions, certain nations have outlawed the use of bromine in electronics and textile applications. Bromine flame retardants now have a sustainable substitute in the form of non-halogenated flame retardants. These alternatives could eventually be a challenge to the expansion of the bromine industry.

Opportunities- Increasing the use of bromine in flow batteries is an opportunity.

Batteries made of bromine can be less expensive than lithium-ion ones. Batteries made of bromine are reliable and stable throughout time and do not deteriorate. Lithium batteries store energy in the electro codes, whereas bromine flow batteries store energy as a liquid in separate tanks. Hydrogen-bromine flow batteries are employed as dependable energy storage solutions in a variety of sectors across the world. They are a dependable source of sustainable power for large-scale industrial units.

Threats- Profound price volatility for oil and gas

One of the main ways that bromine stabilises high-pressure oil wells is in oil and gas drilling. Bromine use in the oil and gas sector has reduced as a result of the decline in demand. In addition, OPEC members have declared that low demand necessitates a reduction in oil output, which will halt new site discovery and oil and gas drilling.

CHAPTER 2- LITERATURE REVIEW

Bromine in Oil-Field Waters and Its Use in Determining Possibilities of Origin of These Waters.

- Gordon Rittenhouse

Based on their bromine concentration, oil-field waters may be categorised into at least five groups:
Group I has a bromine and total dissolved solids content that is about in line with what would be anticipated from the simple concentration of seawater or its dilution with water that has a low bromine and total dissolved solids content.

Group II is comparable to Group I, with the exception that it contains up to twice as much bromine for a given total dissolved solids level. It's possible that early diagenesis introduced the extra bromine.

Group III has more total dissolved solids than seawater, but less bromine than would be anticipated from a simple concentration of saltwater. Halite seems to have been dissolved in these waters.

In Group IV, the bromine level is lower than what would be anticipated from a straightforward dilution of saltwater with water that has low bromine and total dissolved solids contents. These fluids may have been Group III waters diluted with water that had low total dissolved solids and bromine concentration, or they may have been diluted with water that had considerable dissolved solids but high bromine content.

High-salinity waters in Group V have a greater bromine level than those in Group II. These fluids appear to be altered bitterns left over from salt deposition in some cases where there are significant salt deposits. It is unknown where some of these waters come from.

Bromine Content in Some Seaweeds of Goa (Central West Coast of India)

- P.K Mittal

The bromine content of 19 species of seaweed from the Goan coast was assessed using a spectro-photometric approach that involved ashing with Na2C03, oxidising bromide to bromine with chloramine-T, and measuring the absorbance in chloroform at 400 and 650 nm. For the green algae, the bromine concentration ranged from 0.024 to 0.247%, for the red algae, from 0.020 to 0.400%, and for the brown algae, from 0.015 to 0.054%. Only two species, Chondria armata and Codium elongatum, have bromine concentrations of around 4% and 0.247 percent, respectively. These species appear to have a significant amount of organically bound bromine.

Natural goods found in the ocean are distinct from those found on land in a number of ways. The most glaring variation is the preponderance of halogeno-compounds in terrestrial plants and animals. This is most likely due to the high amounts of at least two halogens, notably chlorine and bromine, in sea water. Beginning in the early 1950s, chemical analyses of Indian seaweeds were conducted. According to Umamaheswara Rao (1970), these investigations mainly focused on the polysaccharides (agar and alginic acid), proteins, and mineral elements. Only the iodine halogen has been thoroughly explored (Pillai 1956, Kappanna and Rao 1962, Dave et al 1969, Solimabi and Das 1977). The bromine content of Indian seaweeds is essentially unknown at this point. Several intriguing biological activities have been discovered for the bromo-compounds from marine algae (Bhakuni and Suva 1974). As a result, we decided to check the bromine content of the sea algae in the Goa region and identify any species that may include such chemicals. This research was conducted as a component of the project on marine flora and fauna-derived biodynamic chemicals.

Development status and future development trend of bromine

- Y. Zang

One of the crucial chemical raw ingredients is bromine. Scholars both domestically and internationally place a high value on its preparation technology and application value. This essay discusses local and international bromine production and sales, outlines the method and benefits and drawbacks of commercial bromine extraction, and suggests a direction for the industry's future growth.

The first element found and extracted from saltwater is bromine. The chemical raw material bromine is widely Used. The yearly global production in 2016 was around 820,000 tonnes. With China's economy expanding quickly in recent years, market demand has increased significantly. However, the current situation of Chinese resource is concerning when compared to nations with significant bromine resource. The business is faced with the challenge of conventional bromine supplies running out, making mining harder and harder. In Laizhou Bay, Shandong Province, subterranean brine is mostly used to manufacture China's bromine. Since the 1990s, more than 40% of the subsurface brines' entire bromine reserves have been mined. Additionally, the original 350 g/m3 average bromine content of subterranean brines has decreased. Due to the drastic reduction in the overall quantity and quality of conventional brine supplies, bromine supply and demand have been abnormally low up to this point (200 g/m3). Therefore, the problem of China's bromine resource deficit may be somewhat reduced by making full use of bromine resources in cultivated brines.

CHAPTER 3- METHODOLOGY

In this part I would try my best to explain my approach in writing this dissertation and methods that I have used to conduct this research.

Research Design- Observational Type- Analytical and geographical

Setting: This study would be secondary, focusing on obtaining data from already-existing surveys, legal papers, reports, regulatory documents, and recommendations. The data provided by CPCB & MPCB guidelines are also key sources of data.

Study Population- Business leaders, industrial professionals, public servants, and members of pollution control boards.

Data analysis plan- which includes using Google Analytics and Microsoft technologies to analyse reports and surveys.

Ethical Considerations- The research will be conducted in accordance with the necessary research standards. The approval of the responders will be sought, and the necessary authorization will also be carried out, to guarantee the use of the information they supply. Before the respondent's identify is made public, their permission is necessary.

Research Implications- This research is valuable for comprehending the marketing, production, and consumption of the chemical element as well as for learning about current business trends.

CHAPTER 4- FINDINGS & DISCUSSION

The data findings of how the bromine market is performing in India and global scale and its financials with market analytics are going to be presented in this part also the regulatory framework for obtaining renewal and permission for the Maharashtra pollution control board with its process is going to be there in this findings/results part of the research.

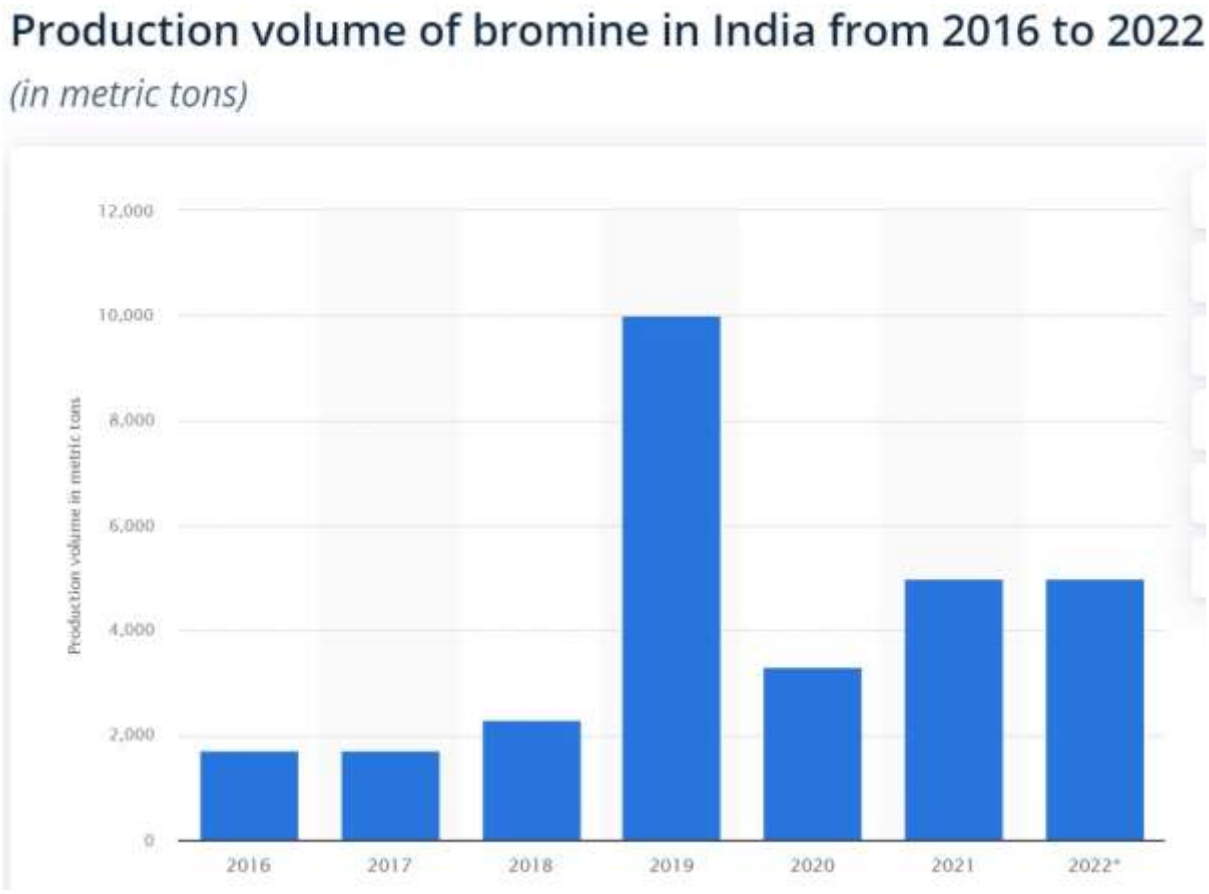


Fig 4.1

The above graph showcases that how there is consistent growth in the production of bromine by volume from the year 2016 to 2022 and in 2019 right before covid there was a sudden high surge in the production and from 2020 to 2022 due to covid the production fell but started gaining momentum again.

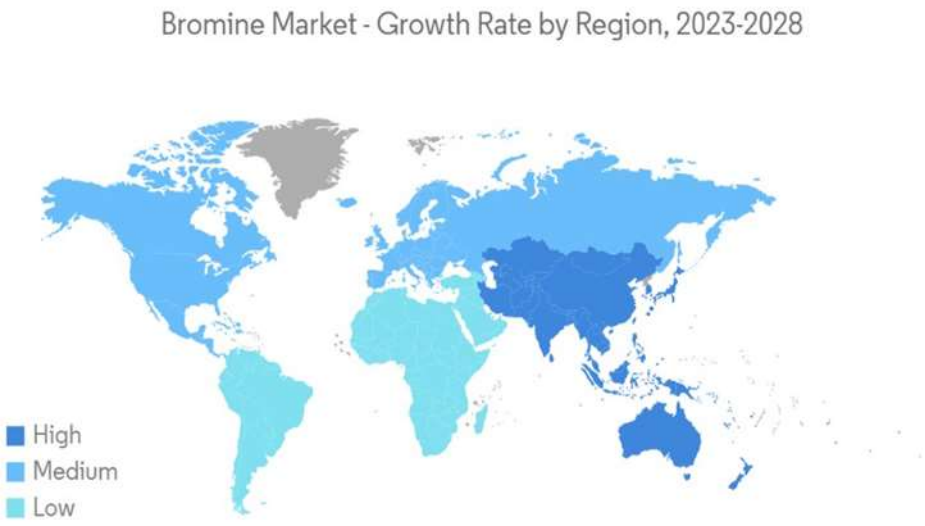


Fig 4.2

The above image indicates the growth rate of bromine market by region we can see that there is hight growth rate in the emerging Asian market such as India and China also the Asia-pacific region of Australia has higher growth rates than developed markets like USA and Europe.

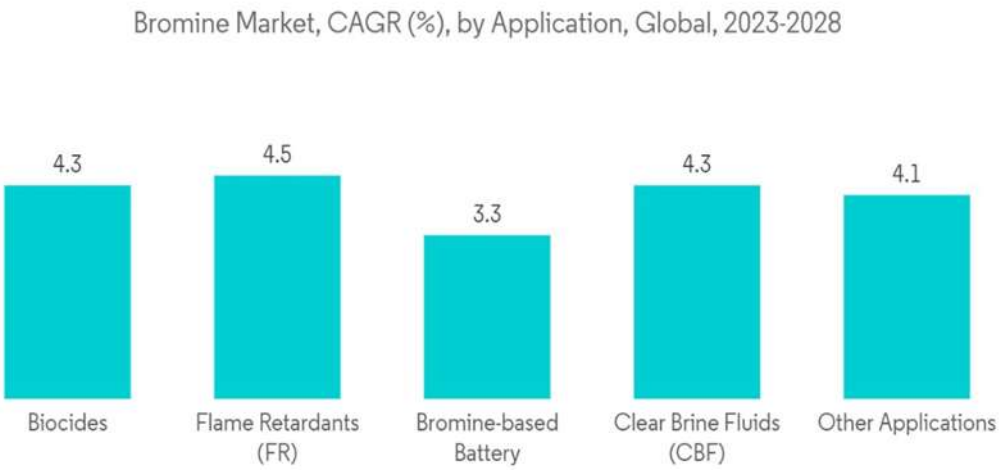


Fig 4.3

The global bromine markets by its application and its CAGR from 2023-2028 forecast can be indicated in the above graph.

Biocides and clear brine fluids tie at 4.3% growth.

Flame retardants maintains its highest growth application in bromine segment at 4.5% growth.

Bromine based battery is at the lowest, while other applications stood at 4.1%.

Bromine Market Analysis-

During the forecast period, the bromine market is anticipated to grow at a CAGR of more than 4%. COVID-19 had a negative effect on the market in 2020. The market is currently thought to have recovered to pre-pandemic levels, and further growth is anticipated.

During the projected period, bromine's rising demand in water treatment applications is anticipated to drive market expansion.

Non-halogenated flame retardants, on the other hand, are probably going to impede the market's expansion.

The Asia-Pacific region is anticipated to have the largest market share throughout the projection period. This is due to the development and growth of China, Japan, and India.

Bromine Industry Segmentation-

At room temperature, bromine, a halogen chemical element, is a reddish-brown liquid. It irritates the skin and eyes and has a strong fragrance. Market segments are created based on location, applications, and derivatives. Organobromines, bromide salts, and hydrogen bromide are the market segments according to derivative. The market is divided into many application categories, including biocides, flame retardants (FR), bromine-based batteries, clear brine fluids (CBF), and other uses. The research also includes market sizes and projections for 15 other countries throughout the world. Market sizing and forecasting have been done for each category based on volume (kilotons).

Top Global Key Players-

- Albemarle
- Jordon bromine company
- Lanxess
- ICL
- Solaris Chemtech
- Tata Chemicals
- Tosoh

Capacity of Production by Key Players

PRODUCERS	CAPACITY MPs
Albemarle, Magnolia, Ark	310
Dow Chemicals, Michigan	325
Great lakes chemicals, El Dorado, Ark	260
Great Lakes Chemicals, Marysville, Ark	130
TOTAL	**725**

Table 4.1

International Distribution of Bromine Production for the year 2000

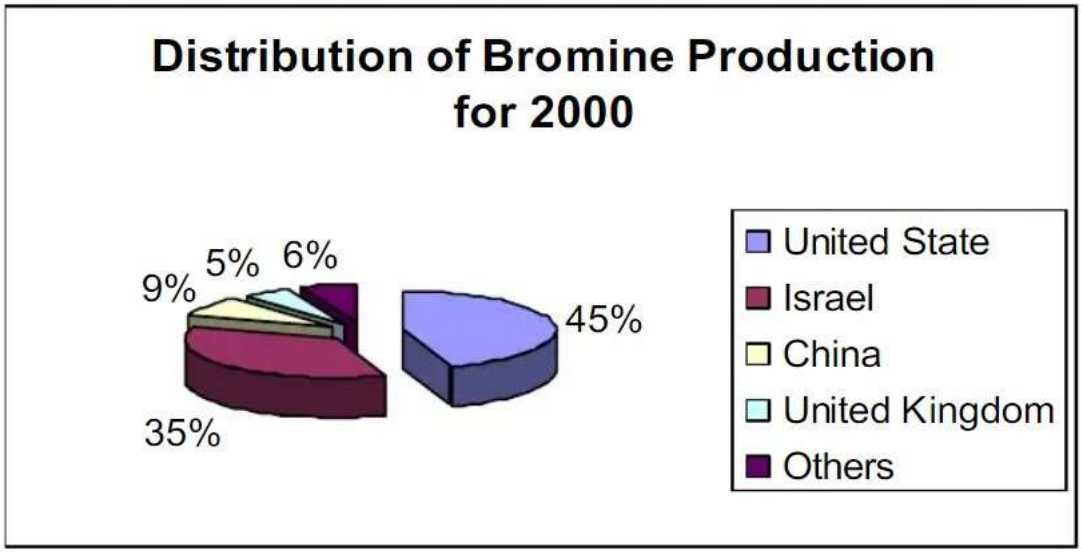


Fig 4.4

Market Trends-

Demand for Flame Retardants is rising.

- Because it effectively puts out flames, It is frequently used as an important ingredient in flame retardants.
- There are over 80 distinct varieties of brominated flame retardants (BFRs) on the market, each with a unique set of chemical characteristics. Brominated bisphenols, diphenyl ethers, cyclododecanes, phenols, phenoxy ethanes, and derivatives of phthalic acid are a few of these.
- BFRs are frequently used to stop electrical and electronic devices from catching fire.
- To prevent or delay the spread of fire, brominated flame retardants are also utilised.
- Globally expanding building projects are driving up necessity for bromine and its compounds for use in these applications. China is one of the top nations for the building of retail centres, for instance. Nearly 4,000 shopping malls already exist in China, and another 7,000 are expected to build by 2025.
- According to the Infrastructure and Project Monitoring Division of the Ministry of Statistics and Programme Implementation, as of May 2022, there were 1,559

projects in India's pipeline worth INR 26.7 trillion (USD 314.22 billion). The robust pipeline of infrastructure projects in numerous industries is also predicted to help the Indian construction industry develop at a 6.2% annual pace from 2023 to 2026.

- Over the next five years, all these factors will increase demand for brominated flame retardants.

World production (Ton/year) of bromine

COUNTRY	1996	1997	1998	1999	2000
Azerbaijan	2000	2000	2000	2000	2000
China	41400	50100	40000	42000	45000
France	2000	2000	2000	2000	2000
India	1500	1500	1500	1500	1500
Israel	160000	180000	185000	185000	185000
Italiy	300	300	300	300	300
Japan	15000	15000	15000	15000	15000
Spain	100	100	100	100	100
Turkmenistan	100	150	150	150	150
Ukraine	3000	3000	3000	3000	3000
Great Britain	30600	35600	35900	55000	55000
USA	227000	247000	230000	239000	228000
TOTAL	**483000**	**542000**	**520000**	**550000**	**542000**

Table 4.2

Usage of Bromine according to percentage-

TYPE	PERCENTAGE %
Flame Retardants	46
Drilling fluids	20
Brominated Pesticides	9
Water- treatment Chemicals	9
Photographic chemical and dyes	5
Pharmaceuticals	4
Rubber additives	2
Others	5

Table 4.3

China has a high demand for bromine.

- China, along with Israel, Jordan, and the US, is one of the top producers of bromine. The main use of bromine in China is for flame retardants. According to the most recent study released by USGS there was total output of 75,000 tonnes in China in January 2022.
- To prevent or suppress combustion, brominated flame retardants are employed in the building industry, the electrical industry, etc.

- About 6.9% of China's GDP was produced by the building industry in 2022. The Chinese Ministry of Housing and Urban-Rural Development further states that during the 14th Five-Year Plan period (2021-2025), the construction industry plans to retain 6% parts of the nation's GDP by 2025.
- The greatest base for the manufacture of electronics is located in China. The electronics segment's fastest-growing product categories were wires, cables,

computing equipment, and other personal electronic gadgets. The nation meets the need for electronics domestically and exports electronic products to other nations, creating a significant market for bromine.

- Because of the expanding electric car industry in the area, China is one of the mass leader in bromine based zinc batteries market. According to the China Association of Automobile Manufacturing, from December 2021 to December 2022, the nation produced 96.9% more new energy cars.
- As a result, during the next years, the aforementioned variables are projected to result in an increase in China's demand for bromine.

Indian Bromine Market

India The demand for bromine was 16.48 thousand tonnes in FY2021 and is anticipated to increase to 25.81 thousand tonnes by FY2030, with a good CAGR of 5.11% from FY2021 to FY2030. Clear brine fluids containing bromine are frequently used in the oil and gas drilling sector. In addition to being a derivative of bromine, clear brine fluids can also include sodium bromide, zinc bromide, and calcium bromide. To lessen the risk of harm to the well bore and productive zone, these fluids are widely employed in the oil and gas well-drilling business. Due to their high density, brine fluids stop subterranean formation fluids from migrating down the well bore. Increased use of bromine in the synthesis of PTA, biocides, and flame retardants is anticipated to fuel the market's expansion.

To fulfil local demand, manufacturers have been forced to move from China to India due to rising labour prices in China. Government programmes like Digital

India are promoting the expansion of the electronics manufacturing industry. This initiative's major goal is to make sure that all government services are available to the public online. The widespread use of bromine in gas extraction, pharmaceutical manufacturing, and oil refractories has made it the most important ingredient for companies nationwide that are in the expansion phase. The oil and gas sector is using bromine compounds more frequently while drilling wells, and they are also widely used as an industrial fumigant in mills, ships, warehouses, and storage facilities.

Due to the interruption of the worldwide supply chain and the suspension of manufacturing operations, the COVID-19 pandemic had a detrimental effect on the bromine market. The continuous pandemic scenario raised demand for pharmaceuticals and wastewater treatment at the same time, which increased demand for bromine.

Solaris Chem Tech, Archean Group, Satyesh Brine, and others are some of the key companies competing in the Indian bromine industry.

Primary research surveys were done with Bromine manufacturers, suppliers, distributors, wholesalers, and end-users in order to get data for the India Bromine market. The interviewees were also asked about their rivals throughout the interview. By using this method, the publisher was able to add producers that secondary research was unable to identify. Additionally, the publication examined several end-user groups and predicted a promising future for the India bromine industry.

The publisher estimated the demand for bromine in India by analysing historical data and taking the price of caustic soda into account. To determine the total market size, the publisher obtained these figures from business representatives and industry experts, and then externally confirmed them by looking at historical sales information from the relevant firms. The study also included a number of secondary sources, including annual reports, association papers, and corporate websites.

Natural Source of Bromine in Sea

SOURCE	ORIGINAL CONTENT, G/L	AFTER CONCENTRATION
SEA WATER	0.065	
Inland Seas		
Kharaghoda, Indian Ocean	0.25	6
Sassyksee, Black Sea	0.28	1.5 to 4.5
Shebhak el Melah, Tunisia	2.5	6.8
SALT LAKES		12 to 13
Dead Sea, Israel	4 to 6	
Ellon Sea, USSR	0.63 to 2.25	
Searles Lake, USA	0.85	
BRINE WELLS		
Michigan, USA	2 to 3	
Arkansas, USA	4 to 5	
Yakutsk, Siberia	6 to 7 (CaCl2 Solution)	

Table 4.4

Bromine in other natural sources

MINERAL SALT DEPOSITS	WT.%
Tachydrite	0.438
Rock Salt	0.005 to 0.040
Sylvite	0.117 to 0.0334
Carnallite	0.155 to 0.0334
Bischofit	0.467
Hard Salt	0.05 to 0.20

Table 4.5

Demand of bromine in the United States

YEAR	DEMAND OF Br2 (MILLION POUNDS)
1996	494
1997	545
1998	510
199	525
2000	515
2001	480
2003	527

Table 4.6

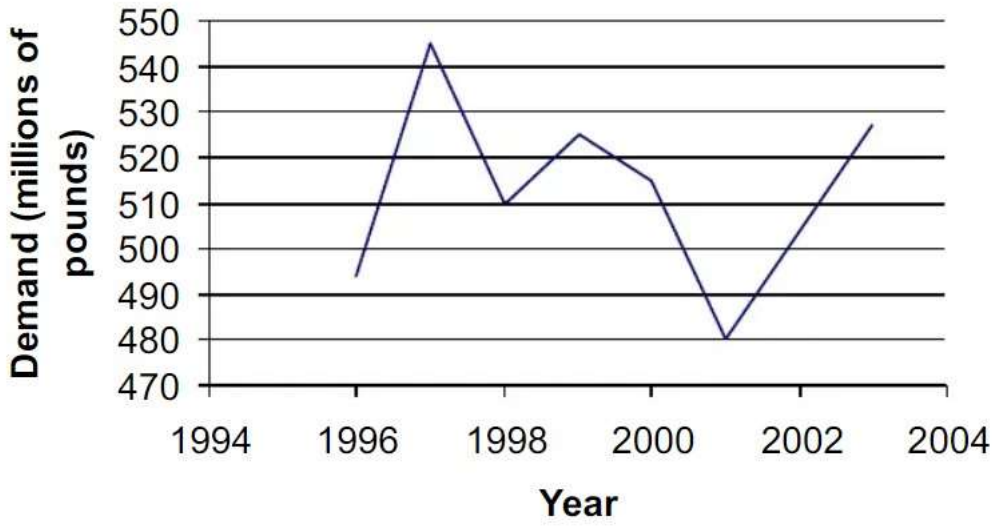


Fig 4.5

Leading producers of brominated flame retardants

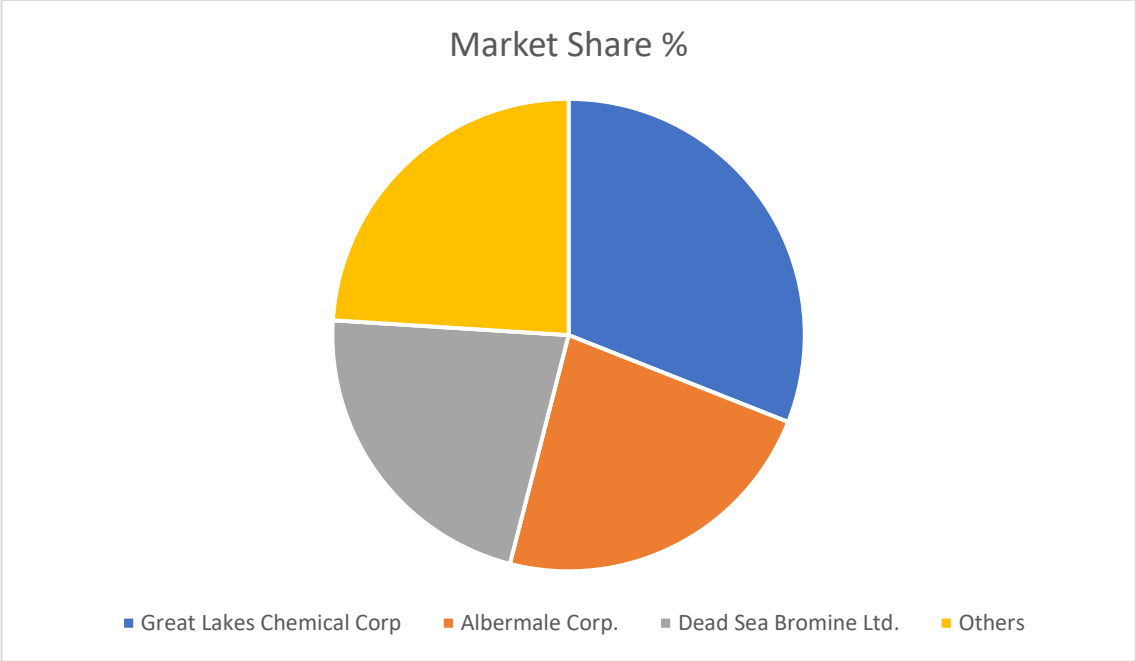


Fig. 4.6

Historical Vs Forecasted Market for Bromine.

Due to the phenomenal expansion of end use industries during the historical assessment period, the historical growth trend of bromine has seen an increasing tendency, driven by rising demand in the end use sector. However, the COVID-19 epidemic has caused the sector to suffer a number of setbacks in 2020. Governmental actions and the rising number of COVID cases have had a negative impact on the industry. Demand was constrained and experienced a drop of roughly -4.6% in 2020.

As the patient graph predicted, government measures to restore different parts of the national economy and the global economy to pre-crisis levels will increase and flatten out in late 2021. A V-shape can be seen in the year-over-year demand graph of the global bromine market as a result of the sudden recovery in bromine demand.

Bromine demand has returned, and it is predicted to remain high for a few years to come. By the conclusion of the forthcoming assessment period, 2023–2033, Persistence Market Research anticipates that the worldwide bromine market will have expanded with a CAGR of 2.7%.

Standard Operating Procedures according to MPCB for Bromine Plant of Hazardous waste category No- 28.1, 29.1 of schedule-1

1. The Utilization of Hazardous Waste:

1. Type of Hazardous waste	Spent Alkali Bromide, Spent Acidic Bromide
2. H.W Category No.	28.1, 29.1 of Schedule-1
3. Source of Generation	Pharmaceutical, Pesticides and Organic chemicals manufacturing units
4. Recovery/Product	Liquid Bromine Recovery and distillation

2. Source of Waste:

1. Generation	Spent Acidic/Alkali Bromide is generated during manufacture of pharmaceuticals, pesticides, and organic chemicals
2. Characteristics	
a. Physical status	Sodium Bromide, Potassium Bromide, Ammonium Bromide, Calcium/ Zinc Bromide and Hydro bromic Acid are liquid in nature.

b. Colour	Colourless to Pale Yellow
c. Odour	Odourless
d. pH	Sodium Bromide & Potassium Bromide are neutral to little alkaline, Hydro bromide is acidic
e. Concentration	Sodium Bromide, Ammonium Bromide, Potassium Bromide powder, Zinc Bromide, Calcium Bromide & Hydro Bromic Acid etc. 10 to 90%
f. Water	68 – 73 %
g. Impurities	2%

a. Utilization Process:

i. Spent Alkali Bromide, i.e., NaBr, KBr are first Concentrated at specific gravity and transferred to reactor.

ii. Then these are acidified in order to de-emulsify the organic impurities present in the waste, the impurities are as bottom residue collected in drums and stored for disposal to CHWTSDF.

iii. Acidified bromide is fed to packed stripping column where chlorine gas and steam are passed from beneath the column.

iv. Chlorine reacts with alkali and liberate bromine as vapours by using steam.

v. Vaporised bromine is condensed to get crude bromine liquid. The acidic effluent generated from the reaction column is sent to ETP.

vi. Crude bromide is further distillated to remove traces of impurities and chlorine. Recovered chlorine is reused in stripping column.

vii. Bromine is again passed through sulphuric acid for removal of moisture and is re- boiled for drying (moisture removal)

viii. Pure bromine is bottled in amber bottles and also collected in drums.

ix. The impurities are collected and stored for disposal to CHWTSDF.

b. Product Uses/Utilization:

- The liquid bromine can be used in pesticides, pharma and other organic chemical industries.
- The product should comply BIS for use as technical grade chemical except pharma/ food grade
- The product be labelled as bromine manufactured by utilising spent acid/ alkali bromine generated from pharmaceutical/ pesticides/

organic chemical manufacturing process.

c. Standard Operating Procedure for Utilisation:

1. The garbage is transported using anticorrosive tankers that have been approved by the SPCB or PCC and are outfitted with the necessary safety measures to prevent spills.

2. Designed space is provided for unloading of spent bromine. Bromine storage tanks are placed on ground with a collection pit for spillage collection. Also provided HDPE liner beneath the storage tank with leachates collection system.
3. Storage tanks are placed in cool, dry, well ventilated sheds within the premises, and vents are connected to scrubber.
4. Proper chemical process pumps are provided for transfer of spent bromine to reactors. There is no manual handling of raw materials and products. All operation are in close system.
5. Acidification reactor is with close system to avoid release of acid mist to the atmosphere. Vent ducts of the reactor are connected to scrubber.
6. Vents of all the storage tanks are connected to scrubber.
7. Separate storage tanks for chemicals are provided with acidic proof lining floor.
8. The utilisation process and the actions that go along with it are separated.
9. Boiler is provided with dust collector followed by a stack as per the consent condition. Height of the stack is 12 mtrs. Coal is used as fuel.
10. Closed loop system provided for transportation of raw material to process system in order to avoid escape of chlorine/bromine gas.
11. The work space and process area have an effective ventilation system. All employees have access to the proper personal protective equipment. The Factories Act is followed when it comes to worker safety measures.
12. Hazardous garbage is purchased from businesses who have received a valid authorization from the relevant SPCB or PCC.
13. We have submitted application along with list of raw material and products with hazardous waste generation which can be synchronised and reflected in the consent and authorization.
14. Transportation of hazardous waste will be carried out only after obtaining authorization from MPCP.

15. Utilisation of hazardous waste will not be started unless authorization from the MPCB is obtained.
16. We have provided physio-chemical (primary) treatment plant for effluent from all the sources. The ETP includes tertiary treatment facilities such as pressure

sand filter and activated carbon filter. Treated effluent is sent to CETP. ETP is adequate so as to meet CETP inlet standards.

17. We ensure to undertake remedial measures in case of environmental damage as per the guidelines published by CPCB.
18. Adequate fire safety measures and flame-resistant electrical fittings are offered.
19. Hazardous waste from all sources shall be stored at a designated storage yard in non-reactive drums or bags and transported to CHWTSDF.
20. We pledge to follow the requirements set out by the Public Liability Act of 1991.

d. Records of Data

1. The passbook issued by MPCB will be maintained properly
2. It will be kept track of the source of hazardous waste purchases, date-by-date usage, product amount, formation of hazardous waste and disposal, effluent discharge emission analysis report, etc.
3. Record of hazardous waste utilization, hazardous waste generation and disposal will be maintained in form 3 and return in form 4 will be submitted to MPCB.
4. The MPCB will receive quarterly and yearly reports on the consumption, source, goods produced, resources preserved, etc. of hazardous waste.

3. Standards:

1. Fugitive emission standards will be maintained as per SOP guidelines for HCI, Cl_2 Br2 etc.
2. Source emission standards for HCI, HBr, NH_3 TOC, chlorine etc will be maintained as prescribed by MPCB.
3. We will monitor specified parameters for source emissions through approved laboratory and submit reports to MPCB.

4. We will treat the effluent to meet the CETP inlet parameters.

a. Siting of Industry:

Our unit is situated in notified Industrial Estate i.e MIDC – Mahad, Dist – Raigad.

M/S Haartz Organics Pvt Ltd. L-48, Addl MIDC, Mahad, Raigad, Maharashtra.

b. Size of Industry and Efficiency of Utilisation:

i. We are a small-scale industry with the capital investment Rs. 319 Lakh Capacity of the pant to utilise Hazardous waste is 12000 TPA and that is quite enough for utilization of Hazardous waste quantity we applied for.

c. Online Detectors/Alarms/ Analyzers:

We have provided detectors and alarm system for chlorine and bromine. The plant is operated batch wise.

d. Checklist of Minimal Requisite Facilities:

1	A storage tank with enough space is needed to keep used alkali bromide for at least two weeks.	:	Provided
	Storage tanks must be elevated above the surface and enclosed by a low-rise parapet or bund wall with a slope to collect any slippages into a collecting pit. As an alternative, HDPE liners with lenehate collecting systems can be installed underneath the HDPE liners in shortage tanks.		Yes Collection pit
2	Within the premises, there are cool, dry, well-ventilated storage buildings for used alkali and acidic bromide tanks.	:	Yes
3	Automated systems for moving used alkali and acid bromide from tankers to storage tanks and from storage tanks to each unit operating	:	Yes
4	The process unit must have enough ventilation (ideally, ventilation pipes linked to ID fans with exhaust above roof level	:	Yes

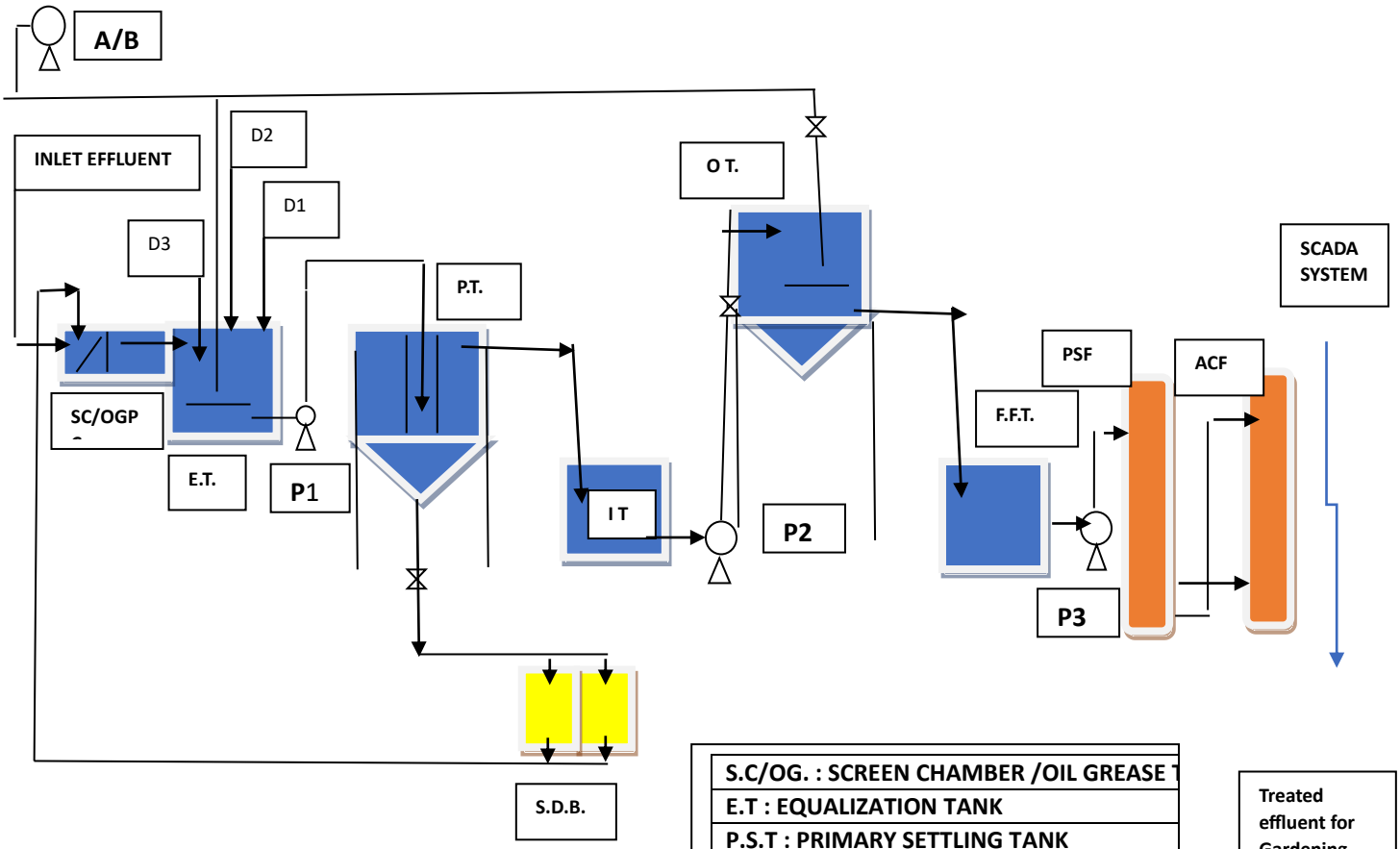
should be placed above the process units).

5	Acidification reactor	:	Yes
6	Stripping column	:	Yes
7	Distillation Column	:	Yes
8	Filter Press	:	Nutch filter provided
9	Cooling tower	:	Yes

Boiler operated electrically or by fuel as permitted by the concerned SPCB/PCC depending upon type of fuel, suitable air pollution control devices shall be installed with the boiler followed by stack of height as prescribed by the concerned SPCB/PCC	:	Provided Coal fired boiler with cyclone dust collector followed by stack of 12 mtrs which is as per MPCB Consent Condition
Suction agreement to suck vapours from suction hood system provided over acidification reactor, stripping column, bromide bottling section and for channelizing the fumes to the vent followed by stack	:	Yes
Adequate effluent treatment plant followed by suitable treatment to meet inlet norms of CETP, through technologies like advanced Oxidation Process (AOP) or Reverse Osmosis (RO) or Multi Effect Evaporator (MEE). In case, CETP is not available zero discharge conditions as prescribed by the concerned SPCB/PCC shall we meet.	:	We have provided Physio-chemical treatment plant followed by PSF and ACF. Treated effluent is sent to CETP for further treatment and disposal.
According to the instructions on the procedures for source emission monitoring published by the CPCB under laboratory analytical techniques, the stack must contain a sampling port, a platform, access to the platform, etc. LATS/80/2013-14	:	Yes
space designated for the temporary storage of hazardous waste produced during the utilisation process	:	Yes

FLOW DIAGRAM:

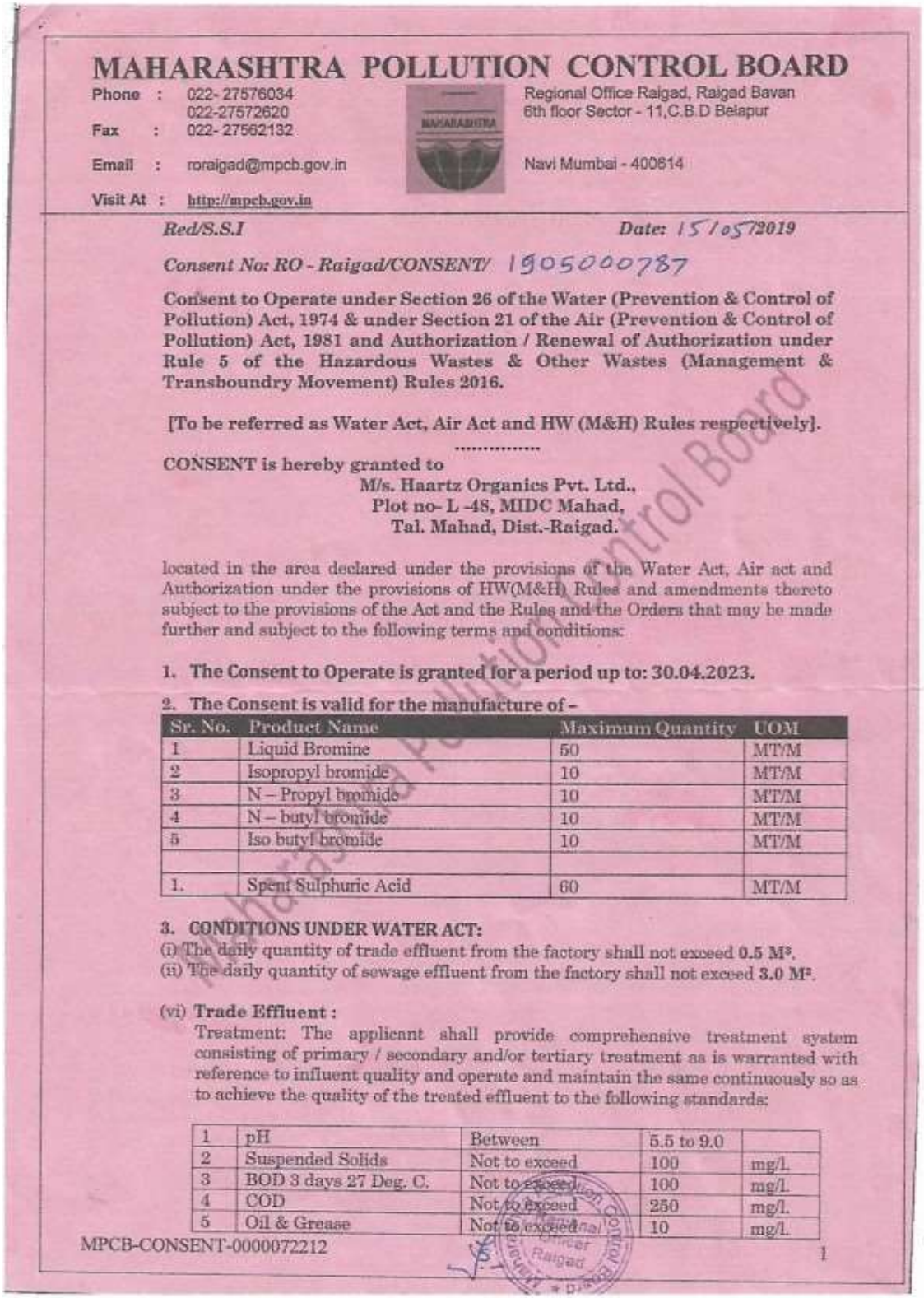
EFFLUENT TREATMENT PLANT



S.C/OG. : SCREEN CHAMBER /OIL GREASE T
E.T : EQUALIZATION TANK
P.S.T : PRIMARY SETTLING TANK
I.T. INTERMITANT TANK
F.F.T.: FILTER FEED TANK
S.D.B : SLUDGE DRYING BEDS
P.S.F : PRESSURE SAND FILTER
A.C.F : ACTIVATED CARBON FILTER
P1: EFFLUENT TRANSFER PUMP
P2:SLUDGE RETURN PUMP
P3: FILTER FEED PUMP
D1/D2/D3/D4: CHEMICAL DOSING TANKS A/B : AIR BLOWER O T " Oxidation Tank
D1/D2/D3/D4: CHEMICAL DOSING TANKS

Fig 4.7

Consent to operate by MPCB



MAHARASHTRA POLLUTION CONTROL BOARD

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Regional Office Raigad, Raigad Bavan
6th floor Sector - 11,C.B.D Belapur
Navi Mumbai - 400614

Red/S.S.I *Date: 15/05/2019*

Consent No: RO - Raigad/CONSENT/ 1905000787

Consent to Operate under Section 26 of the Water (Prevention & Control of Pollution) Act, 1974 & under Section 21 of the Air (Prevention & Control of Pollution) Act, 1981 and Authorization / Renewal of Authorization under Rule 5 of the Hazardous Wastes & Other Wastes (Management & Transboundry Movement) Rules 2016.

[To be referred as Water Act, Air Act and HW (M&H) Rules respectively].

.....

CONSENT is hereby granted to

M/s. Haartz Organics Pvt. Ltd.,
Plot no- L -48, MIDC Mahad,
Tal. Mahad, Dist.-Raigad.

located in the area declared under the provisions of the Water Act, Air act and Authorization under the provisions of HW(M&H) Rules and amendments thereto subject to the provisions of the Act and the Rules and the Orders that may be made further and subject to the following terms and conditions:

1. **The Consent to Operate is granted for a period up to: 30.04.2023.**
2. **The Consent is valid for the manufacture of –**

Sr. No.	Product Name	Maximum Quantity	UOM
1	Liquid Bromine	50	MT/M
2	Isopropyl bromide	10	MT/M
3	N – Propyl bromide	10	MT/M
4	N – butyl bromide	10	MT/M
5	Iso butyl bromide	10	MT/M
1.	Spent Sulphuric Acid	60	MT/M

3. **CONDITIONS UNDER WATER ACT:**

(i) The daily quantity of trade effluent from the factory shall not exceed **0.5 M³.**
(ii) The daily quantity of sewage effluent from the factory shall not exceed **3.0 M³.**

(vi) **Trade Effluent :**

Treatment: The applicant shall provide comprehensive treatment system consisting of primary / secondary and/or tertiary treatment as is warranted with reference to influent quality and operate and maintain the same continuously so as to achieve the quality of the treated effluent to the following standards:

1	pH	Between	5.5 to 9.0	
2	Suspended Solids	Not to exceed	100	mg/l.
3	BOD 3 days 27 Deg. C.	Not to exceed	100	mg/l.
4	COD	Not to exceed	250	mg/l.
5	Oil & Grease	Not to exceed	10	mg/l.

MPCB-CONSENT-0000072212 1

Fig 4.8

Compliance format

Status of Compliance

Name and Address of the Industry	:	M/s. Haartz Organics Pvt. Ltd, Plot No. L-48, Additional MIDC, Mahad, District-Raigad
Category	:	Red/SSI
Capital Investment	:	Rs. 319 Lakh
Activities	:	Manufacturer of liquid bromide through recoveryfrom spent sodium bromide
Consent Details	:	No. Raigad/CONSENT/1905000787, dated 15/05/2019. Validity: 30/04/2023. Application submitted for renewal vide UAN No. MPCB-CONSENT-0000148188, dated-13/09/2002
Authorization Details	:	Application submitted vide UAN No. MPCB- HW_AUTH0000002053, dated 15/11/2022
Pollution Control Details	:	Water: Eff. Qty: Trade: 0.5 m^3/d Domestic: 3.0 m^3/d Treatments: ETP provided comprising of Collection /Equalization Tank-Neutralisation –Settling Tank- Air purging/polishing, Tank-Intermediate Filter- Filter Feed Tank-

		Pressure Sand Filter- Activated Carbon Filter, Sludge Drying Beds, etc, Disposal – CETP
AIR	:	Fuel – Coal- 700 kg/day ECS to boiler – cyclone dust collector followed by astack of 12 meters. Process emissions: Scrubbers to reactors, storage tanks, and glass columns followed by a stack of 21 Meters

Hazardous Waste	:	Category: 35.3 Type of waste: ETP sludge Quantity: 15 T/A Disposal: CHWTSDF
Solid Waste	:	Coal Ash – 1 T/M -Sale

Details of ETP Equipment

Name of Equipment	**Material of Construction**	**Size**	**Capacity**
Collection/Equalization Tank	RCC	2m x2m x 1mtr	4000 Ltr
Neutralization Tank	HDPE	Dia – 1 meter Height- 1.5 meter	1000 Ltr
Settling Tank	HDPE	Dia – 1 meter	1000 Ltr
Air polishing Tank	HDPE	Dia – 1 meter	1000 Ltr
Intermediate Tank	HDPE	Dia – 1 meter	1000 Ltr
Filter Feed Tank	HDPE	Dia – 1 meter	1000 Ltr
Pressure Sand Filter	FRP	Dia – 400 mm Height – 1250 mm	-2000 Ltr
Activated Carbon Filter	FRP	Dia – 400 mm Height – 1250 mm	-2000 Ltr
Sludge Drying Beds	RCC	1x1x1 (2)	-500 Ltr

Table 4.7

Treated Effluent Quantity

Parameters	**CETP Intel Standards**	**Actual value**
1. COD	3500 ppm	48 – 880 ppm
2. TSS	100 ppm	15 – 83 ppm
3. TAN	50 ppm	1.4 – 15.4 ppm
4. TKN	50 ppm	8.4 – 19.6 ppm
5. TDS	2100 ppm	1600

Table 4.8

Glass Lined Reactors for acidification & distillation

Fig 4.9

Neutralization tank to neutralize waste before treatment

Fig 4.10

Zero discharge system for wastewater treatment

Fig 4.11

CONCLUSION

After working for 3 months in the manufacturing unit I was able to understand a great deal about the workings of the industry.

During my internship was in purchase and sales domain, I had to regularly check for the prices of the raw materials that were used in the manufacturing process such as Chlorine Gas cylinders, Coal, Sulfuric acid. Since the prices keep changing and if the price go down I sometimes even had to call the sellers and ask for a credit note for future purchases. I also had to place orders for these materials over email according to the production. In my internship my communication and negotiation skills were brushed.

With practical experience we learn the actual situation of the business like when ordering these materials, the seller asks for past payments and sometimes I even had to make things up to like the Internet banking server is down, etc.

The major challenge faced by me during this internship was the language barrier, the company is located in Maharashtra, and I did not know Marathi so that was an issue sometimes.

The company also had to renew their MPCB consent to operate which expires every 5 years, so I was grateful to be part of the process it really helped me understand the procedure and how to deal with these pollution control boards. The industry is very vast, and the research explains how it still has a huge role to play in the emerging market such as India. The procedure for obtaining a new consent to operate or renewal has also become now centralized which has proven to be very effective.

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ANNEXURE-1

PLAGARISM REPORT

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