A STUDY IN SOME ASPECTS OF CHLORINE MARKETING IN INDIA

A Thesis Submitted in
Partial fulfilment of the requirement of the
Degree of Doctor of Philosophy

by

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1982

To
My Parents

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C E R T I F I C A T E

This is to certify that the thesis entitled "A STUDY IN SOME ASPECTS OF CHLORINE MARKETING IN INDIA" submitted by Rakesh Sharma, ID No. 75HS7001 for the award of Ph. D. degree of the Institute, embodies original work done by him under my supervision.

Signature in full
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Name in capital : S. K. Porwal
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Date 21.10.82

P R E F A C E

Chlorine, a by-product of caustic-soda manufacture, has been posing a serious problem to the industry in terms of its disposal and profitable exploitation. The present work has been undertaken to meet partial requirements for qualifying for Ph. D. degree of Birla Institute of Technology and Science, Pilani. It addresses itself to the study of some important aspects of chlorine marketing. It covers the period 1965 to 1980, and also attempts a forecast of chlorine demand during the following decade.

The opening chapter gives a brief background and outlines the objectives and scope of the study. Chapter II deals with the history of the development of chlor-alkali industry in India. Chapter III takes up the study of the question of chlorine marketing and it is found that the paramount issue in this connection is the necessity to make a reliable forecast of the demand and supply of chlorine during a given period. Its outcome largely determines most other aspects of chlorine marketing. Chapter IV, therefore, concerns itself with the question of an appropriate methodology for chlorine demand analysis. The analysis of both demand and supply of chlorine is attempted in Chapter V. The end-use pattern of chlorine is analysed in the following chapter. The demand, supply and logistics aspects of chlorine form the subject of discussion in Chapter VII. The

last chapter contains conclusions and recommendations.

I am indebted to many friends and colleagues who have helped in various ways in the completion of this work. My deepest obligation and gratitude are, however, due to my teacher and guide, Dr. S. K. Porwal who has recently retired as Group Leader and Visiting Professor, Birla Institute of Technology and Science, Pilani. It is indeed a rare privilege to have studied with a scholar of his eminence and amplitude of easy grasp of the entire gamut of management studies. And now he has immensely added to my indebtedness to him by very generously guiding my work in a difficult field of research. It was he who selected the topic for me from the field of significant relevant research which was outlined that very year by the Institute. But for his constant encouragement and inspiring guidance this work could never have been accomplished. The entire credit for whatever this thesis is worth, therefore, belongs to him, but for all its limitations I alone am responsible.

I would be failing in my duty if I do not thank Dr. C. R. Mitra, Director, Birla Institute of Technology and Science, Pilani who has not only given a new direction to research in the Institute, but also has always taken a living and personal interest in the progress of on-going

research in the Institute.

To Dr. V. K. Tewary, Dean, Research and Consultancy Division, B.I.T.S., Pilani, and Prof. K. M. Dholakia, Dean, Faculty Division I, B.I.T.S., Pilani, I acknowledge personal obligation for many kindnesses, continuous encouragement and help.

I further take this opportunity to thank my teacher and present Group Leader, Management Studies, B.I.I.S., Pilani, Dr. J. K. Mital; my colleagues, Shri C. K. Raghupathy, Shri S. K. Jain, Shri L. N. Maheshwari, and Dr. R. P. Bhatnagar for sharing their valuable expertise with me and for many helpful suggestions. I also thank Shri Rajiv Gupta for helping me in developing a computer programme for this study.

In the end I wish to thank Shri D. M. Mishra for typing the manuscript with a rare degree of personal involvement and diligent care.

Date 21.10.82

(RAKESH SHARMA)

C O N T E N T S

CHAPTER I

INTRODUCTION

INTRODUCTION

BACKGROUND

To say that chlorine, caustic-soda and chemicals go together would not be far from truth. Also they possess certain common characteristics as noted below :

> High tonnage; high investment and integrated production system; relatively low price per ton; and little differential between producers in terms of technology[1].

These chemicals pose significant pollution problems attributable to their chemical reactivity, physical properties and toxicological character.

ABOUT CHLORINE

Chlorine is a highly corrosive, poisonous and hazardous gas. It is very reactive and highly irritating to mucous membranes. Even accidental release of the gas can be very dangerous to the community[2]. The gaseous form of chlorine and its compounds most frequently encountered in polluted atmospheres include the elemental chlorine, hydrogen chloride and vapours of a number of chlorinated hydrocarbon solvents, pesticides and herbicides[3]. There is at present a

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1. Michell E., Tarling, "Marketing Heavy Chemicals", Chemistry & Industry, December, 1974, p. 436.
2. "Atmospheric Emissions from Chlor-Alkali Manufacturer", United States Environment Protection Agency, Research Triangle Park, North Carolina, 1971, No. AP. 99.
3. Stern, "Air Pollution", Vol. I., "Air Pollutants - Their Transformation & Transport", 1973, pp. 63-66.

considerable global concern at the presence of chlorinated pesticides and herbicides formed in chlorine atmospheres. Although the amount of such pesticides present in the air is considerably less than the amount ingested from residues in food, there is grave concern that the build-up of these substances in the oceans would adversely affect many of the micro-organisms that form important link in the nitrogen, phosphorus, sulphur and oxygen cycles essential for life on earth.

In origin chlorine has been a by-product of caustic-soda. It has been produced world-wide almost without exception by electrolysis in a stoichometric proportion. For every 1000 K. gms. of caustic-soda produced by this process of manufacture .886 K. gms. of chlorine is produced alongside[1].

However, with changing technology and variations in relative demand and supply situation of caustic-soda vis-a-vis chlorine we find that chlorine has emerged or is likely to emerge from by product stage to a major product stage, making caustic-soda subsidiary one.

This can be evinced in the undernoted four stages which characterise the growth of caustic-soda industry[2].

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1. Scone, J.D., "Chlorine, Its Manufacture, Properties and Uses", Reinhold Publishing Corporation, New York, 1968, p.3
2. Sampath S., "Some Aspects of the Utilization of Chlorine", Proceedings of the Seminar on Chlorine Utilization, Madras University, 1965, p. 41.

STAGES OF GROWTH OF CAUSTIC-SODA INDUSTRY

(i) Demand for caustic-soda in bulk but for little chlorine when chemical causticization is indicated;

(ii) Demand for caustic-soda in large quantities but considerably less of demand for chlorine when electrolytic and chemical processes co-exist;

(iii) Balanced demand for caustic-soda and chlorine when electrolytic process takes over completely; and

(iv) Demand for chlorine exceeding that of caustic-soda when methods of producing chlorine without caustic-soda are sought. This is likely to come in near future.

In this connection the uses of chlorine will also be worth noting.

USES OF CHLORINE

The applications of chlorine are so varied and wide that its production and demand have reached very high levels in industrially advanced countries. One of the major uses of chlorine is for the bleaching purposes either in the form of aqueous solution or in the form of liquid chlorine. The major industries utilizing chlorine as a bleaching agent are :

(i) Rayon Grade Pulp;

(ii) Paper Grade Pulp;

(iii) News Print; and

(iv) Textiles.

Chlorine is also used widely in the manufacture of bleaching powder, another good bleaching agent. Other major

products in the manufacture of which chlorine is used are listed in the following table along with the utilization factor, that gives the percentage of chlorine utilized per ton of manufacture of these products.

TABLE 1.1

S. No.	Product Name	Utilization Factor
1.	Stable Bleaching Powder	.40
2.	Poly Venyl Chloride (P.V.C.)	.75
3.	Benzene Hexa Chloride (B.H.C.)	.90
4.	D. D. T.	1.50
5.	Hydro Chloric Acid (HCl)	.30
6.	Liquid Chlorine	1.00

In addition to the products mentioned in the above table other minor chlorine based products are selected on the basis of their chlorine consumption. These are listed in the following table - along with the utilization factor.

TABLE 1.2

S. No.	Product Name	Utilization Factor
1.	Monochloro Acetic Acid	.38
2.	Carbon Tetrachloride	.20
3.	Phosphorus Trichloride	.77
4.	Chlorosulphonic Acid	.30

ECONOMICS OF CHLOR-ALKALI INDUSTRY

The economic viability of caustic-soda plant lies solely on optimum and profitable utilization of chlorine. Roughly speaking, with the present day capital costs, a minimum utilization of 90 per cent of the chlorine produced together with minimum return of Rs. 400.00 per ton of chlorine is necessary to achieve even a 10-15 per cent DCF on 100 TPD gross roots caustic-soda plant[1]. Further, due to high capital costs, building up of chlorine consuming industries is difficult. Thus, the problem of efficient and economic utilization of chlorine surplus assumes significance not only for caustic-soda manufacturers but also for the nation as a whole. For a manufacturer it is primarily an economic issue. Even if it were economically feasible to market caustic-soda and treat the by-product chlorine as simply an industrial waste, the problem of waste disposal still demands attention as it would involve various pollution hazards. The problem of profitable utilization of chlorine, therefore, has been engaging attention of persons interested in the growth of chlor-alkali industry in our country.

In order to improve economics of caustic-soda production and other related problems the most important task facing

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1. Kharbanda O. P., 'CHLORINE', CHEMOPROFILES : INDIA , Sevak Publications, Bombay, 1979, pp. 97-101.

the chlor-alkali industry is to exploit the several uses and ways of marketing chlorine, preferably with existing facilities.

Another important feature which characterises chlor-alkali industry is that the demand for these products is controlled by few major buyers. It can be concluded, therefore, that the marketing aspects of this vital industry are concerned with a very large manufacturing industry on the supply side which supplies materials to a wide range of industry; and on the demand side with a few major buyers. Quite likely in the near future or at some later date demand for chlorine may rise significantly and thus a study of demand and supply equation over a time horizon is warranted to face the issues in proper perspective.

Any producer or marketier has to keep in mind these aspects while dealing with distribution and transportation of this material.

From marketing point of view one may refer here to Keith Knowlton who divides these chemicals in the following way[1].

CLASSIFICATION OF CHEMICALS

(i) Products developed for a specific purpose by the manufacturer, usually patented and often used in specific tech-

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1. Keith Knowlton, Marketing Managers, Chemicals Divn., CIBA-GEGY (U.K.) Ltd., "Marketing Speciality Chemicals", Chemistry & Industry, May 1974, pp. 432-433.

nological fields : for example, anti-oxidants, light and heat stabilizers, and corrosion inhibitors;

(ii) Chemical intermediaries (and sometimes finished products) required by a customer who does not have the manufacturing capacity himself. Examples of this are intermediators for pharmaceuticals and plastics; such as dyes, pigments, etc.

(iii) Chemical additives used in small quantities, usually less than five per cent, such as specialised surface active agents, chelating agents and so on.

There will of course be some speciality chemicals that fall between these categories. But this classification is on the basis of different types of marketing techniques that are applied and the different ways in which a company may decide to enter this area of chemical industry.

The above classification may be helpful in decision making for selection of a particular marketing technique. But again in case of chlorine this will depend upon the nature of its output i.e. as by-product or in between. Hence, the importance of the study which tries to develop a Model Computer Programme for developing estimates of demand and supply in time perspective.

From national point of view incurring of excessive cross transportation must be minimized if not eliminated.

Today, every caustic-soda manufacturer is taking his own decisions which may lead to cross movements of materials. This involves added but avoidable cost of transportation and causes strain on transportation system too. An effort has been made to study this distributional aspect with a view to make some suggestions for development of some national policy aiming at minimizing the above narrated costs. Probablly it will be of interest to various chlorine producers to form some kind of pool for this purpose.

In industrially advanced nations there is wide ranging exploitation of chlorine in various branches of industry and daily life. In fact over time chlorine in these countries has gained even more importance than caustic-soda. It should, therefore, not be difficult to visualise that in India too the problem of fuller utilization and thus marketing of chlorine can be successfully tackled through proper studies and planning. But it is disappointing to note that no scientific study so far has been undertaken to assess the expected availability and anticipated demand for chlorine.

The present study is an attempt in this direction. The study aims at the development of a scientific methodology to forecast the nature and problems of chlor-alkali industry. This will not only prove helpful in forecasting the dimensions of the problems of Indian chlor-alkali indus-

try but also be useful in application and study of the marketing aspects of significance to the industry.

OBJECTIVES AND SCOPE OF THE STUDY

(i) To develop a forecast for the supply of chlorine for the period 1980-1988.

(ii) To forecast the nature of demand for chlorine for the period 1980-1988.

(iii) To establish scientifically the surplus/deficit of chlorine based on (i) and (ii).

(iv) To suggest growth products and other outlets for effective utilization of chlorine.

(v) To look into the distribution and transportation marketing aspects of chlorine.

LIMITATIONS OF THE STUDY

A study of this type operates within certain limitations. Keeping in mind resource availability and availability of data the proposed study has the following limitations that need to be mentioned :

(i) Only those chlorine utilizing compounds have been considered that are enlisted with Directorate General of Technical Development.

(ii) The present study covers the time period from 1965 to 1980.

(iii) Since data for the year 1973 is not available it has been calculated by using statistical

method : Regression Analysis. This method consists of extrapolating the previous years data (1965-1972) for the year 1973; interpolating subsequent years data (1974-1980) to 1973; and taking the average of two calculated values as production for the year 1973.

(iv) As the details of chlorine compound manufacturing processes adopted in India were not available chlorine utilization has been calculated by taking into account the percentage chlorine content of each compound on molecular basis and stochiometery of the chemical equation of the most widely used process of manufacture.

In the present study only the organised sector has been accounted for. However, it need not be a serious handicap as almost 80 per cent of chlorine utilisation is covered by this sector.

CHAPTER II

CHLOR-ALKALI INDUSTRY IN INDIA : HISTORICAL PERSPECTIVE

CHLOR-ALKALI INDUSTRY IN INDIA - HISTORICAL PERSPECTIVE

The history of development of chlor-alkali industry in India is relatively very short. Its origin and growth is associated with that of caustic-soda industry[1]. Until World War II, more or less the entire requirement of alkalies was being imported. The first two chlor-alkali plants in the country started practically simultaneously at Mettur Dam in South India and at Rishra near Calcutta in early 40's of this century.[2] These early plants were small, each with a rated capacity of only 5 tons a day of caustic-soda. Gradually the capacity of these plants was expanded and by the end of forties attained a level of 19,000 tons per annum. But the production during 1951 reached a level of only 11,000 tons. During all these years till late forties the entire chlorine produced alongwith caustic-soda was disposed of as waste.

During the First Plan period (1950-1955) additional capacities for caustic-soda were set up by Heavy Chemicals Ltd., Madras; Delhi Cloth Mills, Delhi; Calico Chemical Division, Ahemdabad; Eastern Chemical Co. Ltd., Bombay; National Rayons Ltd., Bombay; Orient Paper Mills, Brajrajnagar; Dharandra Chemical, Triunelveli; Jiaji Rao Cotton Mills, Porbandar;

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1. For Early History of Chlorine, see Appendix I.

2. Ramani, R. V., "Chlor-alkali Industry in India", Decennary Commemorative Volume I, Electrochemical Industries in India, (1965-74), pp. 152-153.

Tata Chemicals Ltd., Mithapur and Rohtas Industries Ltd., Dalmia Nagar. As a result of this the installed capacity for caustic-soda became 37,000 tons by the end of the First Plan, while actual annual production by the end of the plan reached the level of 33,000 tons. During this period only a part of chlorine was utilized for bleaching of paper and the rest was treated and disposed of in the form of waste acid.

During the Second Five Year Plan (1956-1961) the targets for installed capacity and production were set at 150,000 tons and 135,000 tons respectively[1]. Most of the existing plants expanded their installed capacity. In addition new plants were set up by the Ahemdabad Manufacturing and Calico Printing Co. Ltd., Ahemdabad; Orient Paper Mills, Calcutta; Nepa Chemical Ltd., Nagpur; Atul Chemical Ltd., Bulsar; Titagarh Paper Mills Co. Ltd., Calcutta; Andhra Sugar Mills, Rajeshmundry; Sripur Paper Mills Ltd., Hyderabad; Century Rayons, Bombay; Travancore Cochin Chemicals (P) Ltd., Udyogmandal and J.K. Chemicals Ltd., Bombay. With this increase in caustic-soda production capacity during the Second Plan period it was realised that if emphasis was laid on full utilization of chlorine, caustic-soda capacity might not be built up fast enough and large imports of caustic soda would be required to meet country's demand. Though the development of paper industry during this period helped off-take of chlorine the percentage utilization remained below fifty percent[2].

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1. "Second Five Year Plan - Progress Report", Government of India, Planning Commission, (1958-59), pp. 96-99.

2. Seshion P.K., "Development of Chlorine Products and Utilization of Chlorine in India" Proceedings, "Seminar on Chlorine Utilization", Madras University (1965), pp. 6-9.

During the Third Plan period (1960-1965), the target for production for caustic-soda was set at 345,000 tons. In order to meet the demand of the consumers from indigenous sources, a target capacity of 406,000 tons per year was fixed for 1965-66[1]. Further, expansion in caustic-soda production took place at Travancore Cochin Chemical, Mettur Chemicals, Alkali and Chemicals, Delhi Cloth Mills and National Rayons Corporation. But the actual production during the year 1965-66 could measure upto only 218,000 tons. Nevertheless this resulted in abundant availability of chlorine as compared to only a limited take-off. During this plan period Delhi Cloth Mills established the production of bleaching-earth using hydrochloric acid and other factories started making minor chemicals such as chlorinated rubber, copper oxychloride, etc[2].

By the end of the period of three annual plans i.e. from 1966-1969 the installed capacity for caustic-soda production stood at 367,000 tons as against actual production of only 346,000 tons. The stress laid on complete utilization of chlorine produced alongwith caustic-soda paved way for development of products like Venylchloride, D.D.T. and Benzene Hexa Chloride, etc. As a result the chlorine utilization improved considerably.

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1. "India-Handbook of Commercial Information", Vol. 1, Department of Commercial Intelligence and Statistics, Calcutta, Government of India (1963), pp. 236-237.
2. Ramani, R.V., "Chlor-alkali Industry in India", Decennary Commemorative Volume I, Electrochemical Industries in India (1965-74), pp. 96-98.

In the Fourth Plan (1969-1974) the targets for caustic-soda capacity and production were set at 560,000 tons and 500,000 tons respectively[1]. The actual installed capacity and production remained short of expectation at 503,740 tons and 432,000 tons respectively.

At the beginning of 1976 total installed capacity in the 33 units was 690,000 tons. Substantial expansion of the units of Mettur Chemicals and Standard Alkalies, as well as marginal expansion of Sriram Chemicals, Tata Chemicals and Titagarh Paper Mills and inclusion of the new unit of Gujrat Alkali and Chemicals contributed to the attainment of 7.1 lakh tons of capacity installation for caustic-soda by the end of 1976[2]. However, capacity utilization of this power intensive industry which had improved to around 80 to 85 percent, during the later part of 1975, remained around 70 to 80 percent throughout the year 1976 due to wide-spread power cuts in most of the states[3].

During the years 1977-79 caustic-soda production showed a steady increasing trend attaining a level of 5.7 lakh tons. In 1980, however, caustic-soda production showed a fall of 3.5 percent i. e. from 5.7 lakh to 5.5 lakh tons

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1. Fourth Five Year Plan (1969-74), Draft, Planning Commission, Government of India, p. 262.
2. "The State of Chemical Industry - 1976", Chemical Age of India, 27th Annual, Section A, p. 31.
3. Ibid, p. 32.

during the previous year. Despite this downward fluctuation in 1980, the installed capacity for caustic-soda increased from 3.9 lakh tons in 1971 to 8.0 lakh tons at the end of 1981. Perhaps the major single factor which was responsible for this fall in caustic-soda production was the severe power shortage. The unsatisfactory power supply adversely affected most of the producing units in different parts of the country[1].

The Fourth Plan period had achieved dimensions that all demand for caustic-soda was met by indigenous producers, with supplies readily and adequately available from many units spread throughout the country[2]. The table on the following page shows caustic-soda installed capacity and production over years.

With the consequent increased production of chlorine, its gainful utilization assumed importance. With expected substantial continuing increases in the production of caustic-soda and correspondingly that of chlorine in future years it was rather doubtful if the proper and gainful utilization of chlorine could be achieved and maintained[3].

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1. "Caustic-soda Output & Power", The Economic Times, March 4, 1981, p. 4.
2. "Caustic-soda Demand Fully Met - Alkali Manufacturers Association Report", Chemical Weekly, September 13, 1977, p. 63.
3. Fourth Five Year Plan (1969-74), Draft, Planning Commission, Government of India, p.262.

TABLE - 2.1

Caustic-soda Installed Capacity and Production

(Tons)

Year	Installed Capacity	Production
1951	27,996	14,964
1956	57,204	40,056
1961	124,440	119,856
1966	295,000	230,459
1971	370,000	376,634
1972	428,220	391,078
1973	439,220	410,544
1974	508,740	431,550
1975	568,800	442,660
1976	690,000	504,100
1977	700,000	517,000
1978	700,000	548,000
1979	765,000	566,839
1980	803,000	549,120

SOURCE : Statistics relating to DGTD Units; Reports; Government of India, Directorate of Public Relations & Publications, Udyog Bhavan, Maulana Azad Road, New Delhi-110011.

As pointed out earlier the demand for caustic-soda and chlorine are not always in the stoichiometeric proportions and depending upon which product is more in demand one of them will be considered as the main and the other one as more or less uncalled for side product. Hence, it becomes important to develop a forecast of the nature of future of chlor-alkali industry and to plan the future course of this industry if it has to truly serve its purpose.

CHAPTER III

MARKETING OF CHLORINE

MARKETING OF CHLORINE

To study and analyse marketing aspects significant to chlor-alkali industry it is appropriate at this stage to look into the concept of marketing and marketing orientations. Besides being useful in the development of forecast about the nature of future of the industry this will provide a basis for marketing planning for chlor-alkali industry in general and chlorine in particular.

There were various shades of meanings attached to the concept of marketing and marketing orientations. To be exact there are as many definitions as there are writers[1-8]. But

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1. "A Statement of Marketing Philosophies", Marketing Staff of the Ohio State University, Journal of Marketing, Jan. 1965, p. 43.
2. Alexandar Ralph S., "Marketing Definitions", American Marketing Association, Chicago, 1961, p. 15.
3. Kottler Phillip, "Marketing Management - Analysis, Planning and Control", 3rd Ed., Prentice Hall of India, New Delhi, 1976, p. 4.
4. Drucker Peter F., "The Practice of Management", Harper and Row Publishers, Incorporated, New York, 1954, pp. 37-41.
5. Condiff Edward W., Still Richard R., Govoni Norman A.P., "Fundamentals of Modern Marketing", Prentice Hall of India, New Delhi, 1974, pp. 3-6.
6. Dodge Robert H., "Industrial Marketing", McGraw-Hill Book Company, New York, 1970, p. 4.
7. Edward Mikay, "The Marketing Mistique", N. Y., American Management Association, 1972, pp. 22-30.
8. Drucker Peter F., "Management Tasks, Responsibilities, Practices", N.Y., Harper and Row Publishers, 1973, p. 64.

For discussion on Concept of Marketing and Marketing Orientations refer Appendix II.

considering the social and economic significance of chlorine and chlor-alkali industry, we propose to largely adhere to Societal Marketing Concept propounded by Kotler Phillip.

The Societal Marketing Concept as defined by Kotler is a management orientation aimed at generating consumer satisfaction and long-term consumer and public welfare as the key to satisfying organisational goals and responsibilities[1].

The chief merit of this concept is that it significantly adds the important considerations of long run consumer and public welfare and calls for a shift of the organisations' perspective to include more marketing participants and long run effects.

The role of chlor-alkali industry calls for adaptation of a marketing orientation that incorporates long-term consumer and public welfare as the key to satisfy industry goals and responsibilities. With respect to chlor-alkali industry this can only be achieved by planning the economic and profitable use of chlorine produced along with caustic-soda, and discovering ways of enabling the industry to perform its role in the development of the nation in a responsible manner.

In spite of manifold sales transactions in producers' markets (also called the industrial or business market) we

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1. Kotler Phillip, "Marketing Management - Analysis, Planning and Control", 3rd Ed., Prentice Hall of India, New Delhi, 1976, p. 16.

fail to recognise the presence of industrial markets because it is partially hidden from our view by the retailing structure. Despite this obscurity, the impact of the industrial market on our everyday life is noteworthy. For consumers or users, the performance of industrial market will have important bearing on such questions as what products are available, how suitable these products are in relation to the needs of the users, and what the price will be for these products. The actions of the industrial markets and its members can have important economic and social implications. These may range from the benefits of economic developments to the problems associated with pollution[1].

Demand is not inherent in the industrial marketing as it is in consumer marketing. Rather, it is derived from the demand for consumer goods and services as well as purchasing by governmental units at all levels.

The demand for industrial goods and sevices, being derived, is activated by ultimate consumer and government purchasing. Frequently it can be said that industrial demand takes on the appearance of what might be described as "boom or burst" cycle. Further, industrial buying is substantially rational in nature. A careful frequently exhaustive study of all the objective factors is generally the

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1. Robert Dodge H., "Industrial Marketing", McGraw-Hill Book Company, 1970, pp. 4-5.

basis for buying products from a particular vendor.

In some limited areas, however, persuasive promotional activity can be applied beneficially to the marketing of chemicals. Publicity can be used in support of agents and distributors with the objective of enlarging the market. Finally, publicity for the company, and skilled public relations, can be employed to maintain and enhance its image so that its manufacturing operations are not unjustifiably hampered. In general these persuasive activities are peripheral to chemical marketing which seeks mainly to influence customer's choice by emphasising assured supply at the right price and quality, and by fulfilling undertakings[1]. The major marketing weapons in the consumer field, e.g. advertising, packaging, distribution and pricing are often important. In commodity type chemicals the only way to obtain higher sales volume is by price cutting which can be self-defeating[2]. The manufacturer of chemicals must therefore rely on information relating to the pattern of demand for the products requiring these chemicals, and on the general statistics and trends, safety standards and so on. Hence, the market forecasts are the most important element in chemical marketing decisions.

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1. Keith Knowlton, Marketing Managers Industrial Chemicals Divin., CIBA-GEGY (U.N.) Ltd., "Marketing Speciality Chemicals", Chemistry and Industry, May 1974, p. 433.

2. M. R. Porter, "The Role of Marketing Research in Chemical Marketing", Chemistry and Industry, May 1974, p. 430.

CHAPTER IV

METHODOLOGY FOR DEMAND ANALYSIS

METHODOLOGY FOR DEMAND ANALYSIS

In industrial marketing and more so in marketing of chemicals most of the decisions require the anticipated demand for the products that utilize these chemicals in their manufacture. Demand forecasting, therefore, assumes great importance in the context of chlor-alkali industry as both the products (caustic-soda and chlorine) offered by the industry fall under the category of intermediate products.

The techniques of forecasting are many but the choice of one suitable to the product or products in question depends largely on the nature and characteristics of the product. To a large extent it also depends on the nature of the data available for the purpose. In economic forecasting the classical methods use historical data in a rather rigorous statistical manner for making future projections. There are also less formal methods where judgement plays a greater part in picking, using and interpreting the available data and where statistical expertise is not so rigorous[1-3]. There are several variations of both statistically formal and less formal methods of forecasting . But in brief, they fall under one or the other of the following categories :

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1. Baiakrishna S., "Techniques of Demand Forecasting for Industrial Products", Sunder Publishers, New Delhi, 1967, p.4.
2. Butler William F., Robert A., Kavesh, Platt B., ed., "Methods & Techniques of Business Forecasting", Prentice Hall Incorporation, New Jursy, 1974, pp. 11-29, 161-189.
3. Churchill A. Gilbert Jr., "Marketing Research - Methodological Foundations", Dryden Press, Illinois, 1976, pp. 26-31.

(i) Trend Method,

(ii) End-use Method, and

(iii) Regression Techniques.

Of the statistical methods available for demand forecasting the one which is found most suitable for chlor-alkali industry is the modified version of end-use method incorporating regression technique. In the end-use method for demand forecasting there are four distinct steps or stages of work. In the first place it is necessary to identify and list applications of the product in question. The second stage of the work calls for the establishment of suitable technical norms of the consumption of the product for which the study is made. Norms have to be established for each and every end-use and can be explained in physical terms either in the form of consumption per unit of production or percentage consumption of complete production in terms of weight, volume, length, or some other relevant measurement.

After establishing the technical norms of consumption the next step is their application. For this purpose, it is necessary to know for predetermined future period/periods the desired or target levels of production of individual industries that make use of these products as inputs for the production of their final products. Simultaneously, the knowledge of the likely developments in the economic activities that affect the output of these products will prove helpful because the norms have to be applied to these output targets.

The fourth and final step in the end-use method is to aggregate the productwise or usewise content of utilization of the product for which the demand study is undertaken. This aggregate result gives the estimate of demand for the industry as a whole for the terminal year in question. By the very nature of the process of estimate stated above, it is obvious that the end-use method results in what may be termed as 'derived demand'.

This approach in demand forecasting has considerable theoretical and practical values since the forecasts made by this method are based on the building up of the probable aggregate demand in the future of the consuming industry and/or sector. It is believed that the technological, structural and other changes that may influence the demand are taken care of in the very process of estimation. This aspect of end-use method is particularly important as in no other method this advantage is available.

There are many other advantages associated with end-use approach in demand forecasting studies. In the first place, it is possible to spell the future demand of an industrial and/or intermediate product in considerable details such as types and sizes. Whereas in all other methods the future demand can be estimated only at an aggregate level. On the other hand by probing into the present use pattern of the product/products in question the end-use method affords every opportunity to determine the types, categories and sizes likely to be demanded

in future. Further, the application of end-use approach makes it possible to trace and pin down at any time in the future as to where and why the actual consumption falls below or rises above the estimated demand. Suitable revision can also be made from time to time based on such an examination.

Data Source

The role of adequate, complete and relevant information cannot be overlooked in any demand forecasting exercise. Though attempts were made to collect the primary time-series data relating to the production of the products utilising chlorine and its percentage utilization per ton, no fruitful results were obtained. We, therefore, relied upon the secondary sources of data and in this respect made use of the information compiled by Directorate General of Technical Development (D.G.T.D.). The acquired data on caustic-soda production and thus chlorine and also the chlorine based compounds are listed in Appendix III.

Further to obtain required information with respect to licenced capacity, installed capacity and actual production for individual undertakings in the country we have mainly relied upon the 'Stock Exchange Directory.' For those units that are not listed in the Directory, 'Sanctioned Capacity for Non-engineering Industries', a publication of National Council of Applied Economic Research (N.C.A.E.R.) and 'Chemical Industrial Undertakings - Licenced ' a publication of All India Chemical Manufacturers Association

have been referred.

In order to achieve the objectives of the study, the end-use method incorporating regression technique is adopted. All calculations for this purpose were performed on IBM - 1130. The detailed Fortran programme is listed in Appendix IV.

CHAPTER V

CHLORINE SUPPLY AND DEMAND

CHLORINE SUPPLY AND DEMAND

SUPPLY OF CHLORINE

Making use of the methods and tests mentioned here the calculated values have been obtained for the year 1965 to 1980. These calculated values are listed in tables appearing later along with each individual item. In addition to this chlorine availability is calculated by multyplying the caustic-soda production by the factor value .88.

Further, on the basis of these calculated values extrapolation has been done. The projected values for the years 1981 to 1988 have been obtained. The projected values are presented along with the analysis of each product. These values are listed in tables that appear subsequently. Making use of the results so obtained, the yearwise total availability of chlorine and its percentage utilization has been calculated.

In order to further validate the forecast, a leading characteristic of chlor-alkali products i.e. their great generality of use has also been considered. Almost all sectors of economy employ these products in some form or the other. It seems reasonable, therefore, to relate the effective demand of caustic-soda and thus chlorine to an aggregate measure of economic activity, specifically to Net National Product (N.N.P.). This has a definite advantage

because the forecasts of future values of N. N. P. are available from a number of sources. It is obvious that a forecasting method will be of little value if it requires explanatory factors which cannot themselves be forecast with reasonable accuracy. This consideration is particularly important for periods characterised by cyclical fluctuations. In view of this fact a study of relationship between caustic-soda production and N. N. P. is justified. This will not only enhance the reliability of the estimates of forecast of caustic-soda but also that of chlorine availability.

Since caustic-soda is taken to be the only source of chlorine and many industries share the utilization of this chlorine in the production of various products, naturally we expect a certain degree of corelation between caustic-soda and these items and also among these items. A cross corelation metrix has been developed to this effect.

CHLORINE PRODUCTION AND N. N. P.

Table 5.1 shows the Net National Product from the year 1965 to 1978 along with the chlorine availability for the same years. The N. N. P. from a low value of 20,001 in 1965 increases to 66,885 in 1978, which is more than three times the value in 1965. Chlorine production also shows a tremendous increase during the same period. From a comparatively low value of 1,89,160 tons in 1965 the chlorine production in India has risen to 4,82,240 tons in 1978 which

TABLE 5.1

CORRELATION BETWEEN CHLORINE AVAILABILITY AND N.N.P.

YEAR	NET NATIONAL PRODUCT	CHLORINE AVAILABILITY
1965	20001.00	189160.40
1966	20637.00	202303.93
1967	23484.00	237020.96
1968	28054.00	269197.31
1969	28607.00	304840.81
1970	31606.00	318076.00
1971	34462.00	331437.93
1972	36332.00	344148.68
1973	39643.00	361278.75
1974	49396.00	379764.00
1975	58137.00	389540.81
1976	60293.00	443608.00
1977	64279.00	454960.00
1978	66885.00	482240.00

CORRELATION COEFFICIENT BETWEEN CHLORINE AVAILABILITY AND N.N.P. = 0.9602

is also a threefold increase. The above figures emphasise that chlorine production is one of the important indices of nation's progress. This fact is further substantiated by the high degree of corelation between N. N. P. and chlorine availability. The corelation coefficient happens to be 0.9602 which implies more than 96 per cent corelation.

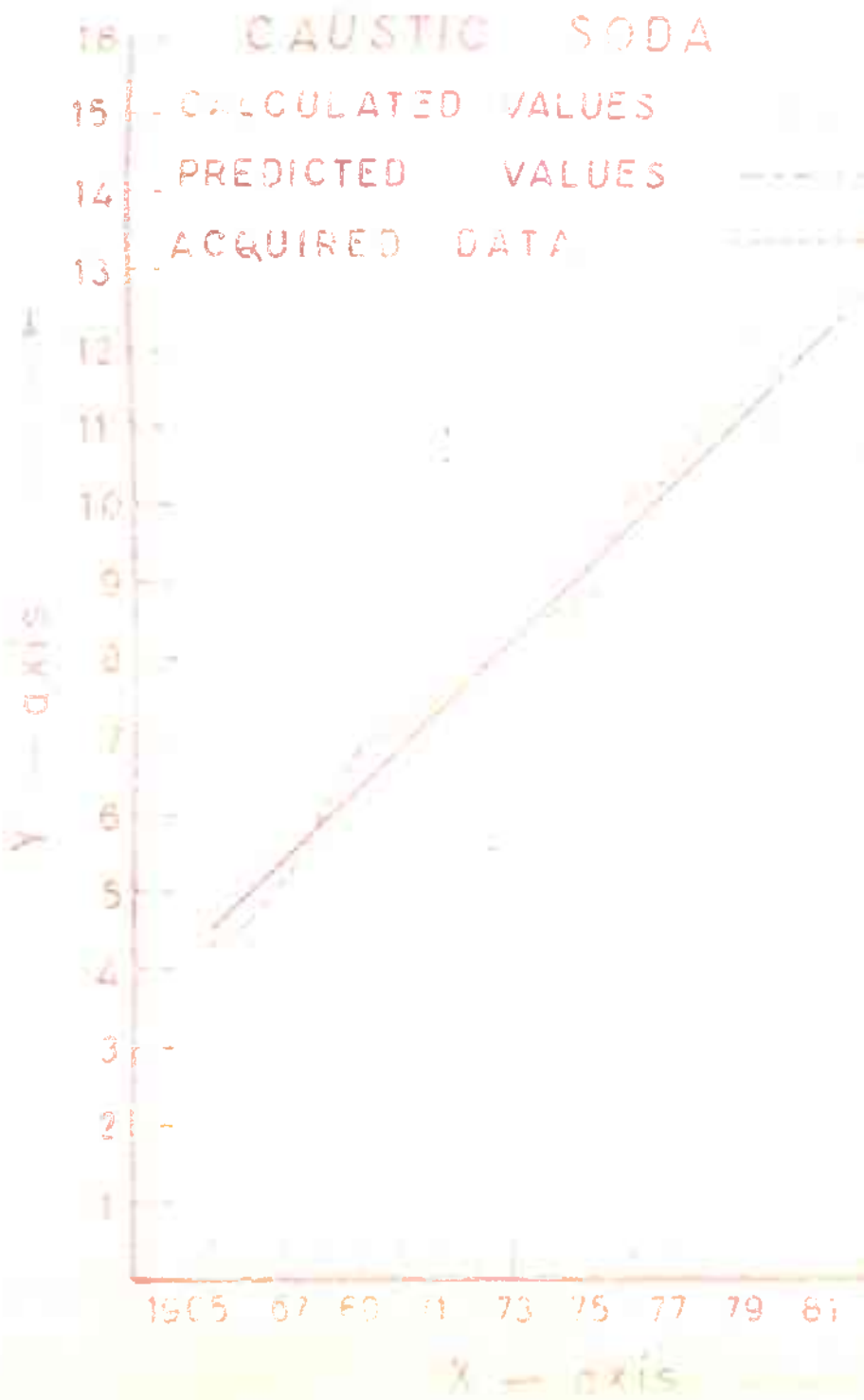
CHLORINE AVAILABILITY - CAUSTIC-SODA PRODUCTION TREND

In India caustic-soda production is the only source of chlorine. In 1965 caustic-soda production was 214.95 thousand tons which resulted in 189.16 thousand tons of chlorine availability (Table 5.2). In later part of sixties and early seventies the caustic-soda industry grew relatively fast. The fast growth can be explained by the large demand for caustic-soda and chlorine both. The year 1967 saw the highest growth rate in caustic-soda production which was as high as 16.8 per cent. Starting from 1965 the caustic-soda industry is continuously growing but with a steadily decreasing growth rate. The steady decrease in growth rate is largely because of the increased production which is coming close to the target slowly. The tentative target for caustic-soda is 64 thousand tons in 1982 which will be attained within this decade.

On the basis of our forecast of caustic-soda production for this decade (Table 5.3) we can say that 1983 will see

the attainment of our target in caustic-soda production. Thus this is the time to shift our attention from caustic-soda to chlorine. Because of diverse uses of chlorine in many industries it is quite likely that the demand for chlorine will go on increasing. In the present perspective we won't be very wrong if we consider chlorine as the main product and caustic-soda as a co-product. As was evidenced during the growth pattern of developed countries also, to begin with it is caustic-soda which gets more attention but as the process of industrialization grows, ultimately it is chlorine which becomes more important. Eighties will see this change in the scene.

In 1981 the caustic-soda production is expected to be 604.58 thousand tons yielding 532.12 thousand tons of chlorine. The growth rate will be 4.06 per cent which is very low compared to actual growth rate of 16.8 per cent in 1967. In 1983, 573.65 thousand tons of chlorine will be produced and from then onwards there will be only marginal increase in its production; if we don't go in for the development of alternative sources of chlorine. However, if we push the target back, according to the forecast in 1988, 769.85 thousand tons of caustic-soda will be produced giving rise to 677.46 thousand tons of chlorine availability. This much chlorine may still fall short of the demand while the corresponding amount of caustic-soda may be in excess of what is desired, resulting in an almost reverse situation, without a


CAUSTIC SODA
CALCULATED VALUES
PREDICTED VALUES
ACQUIRED DATA
16
15
14
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11
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9
8
7
6
5
4
3
2
1
Y — axis
1965
67
69
71
73
75
77
79
81
X — axis

SCALE

1 Cm = 50,000 tonnes

TABLE 5.2A

CAUSTIC-SODA

CALCULATED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE PRODUCTION	GROWTH-RATE (PERCENTAGE)
1965	227165.6	199905.7	--
1966	250760.6	220669.3	10.38
1967	274355.6	241432.9	9.40
1968	297950.6	262196.5	8.60
1969	321545.5	282960.0	7.91
1970	345140.5	303723.6	7.33
1971	368735.5	324487.1	6.83
1972	392330.5	345250.8	6.39
1973	415925.5	366014.4	6.01
1974	439520.4	386777.9	5.67
1975	463115.4	407541.5	5.36
1976	486710.3	428305.1	5.09
1977	510305.3	449068.6	4.84
1978	533900.3	469832.2	4.62
1979	557495.3	490595.8	4.41
1980	581090.3	511359.4	4.23
AVERAGE	404127.7	355632.4	6.47
STD. DEV.	112334.5	98854.3	1.90

THE CORRELATION CO-EFFICIENT IS 0.9902

F(1,16) = 704.1104

THE CONFIDENCE INTERVAL IS 889.2702

TABLE 5.3

CAUSTIC-SODA

PREDICTED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE PRODUCTION	GROWTH-RATE (PERCENTAGE)
1981	604685.2	532123.0	4.06
1982	628280.2	552886.6	3.90
1983	651875.2	573650.1	3.75
1984	675470.2	594413.7	3.61
1985	699065.1	615177.2	3.49
1986	722660.1	635940.8	3.37
1987	746255.1	656704.5	3.26
1988	769850.1	677468.0	3.16
AVERAGE	687267.62	604795.25	3.57
STD. DEV.	57795.64	50860.14	0.31

change in strategy towards the end of the decade.

DEMAND FOR CHLORINE

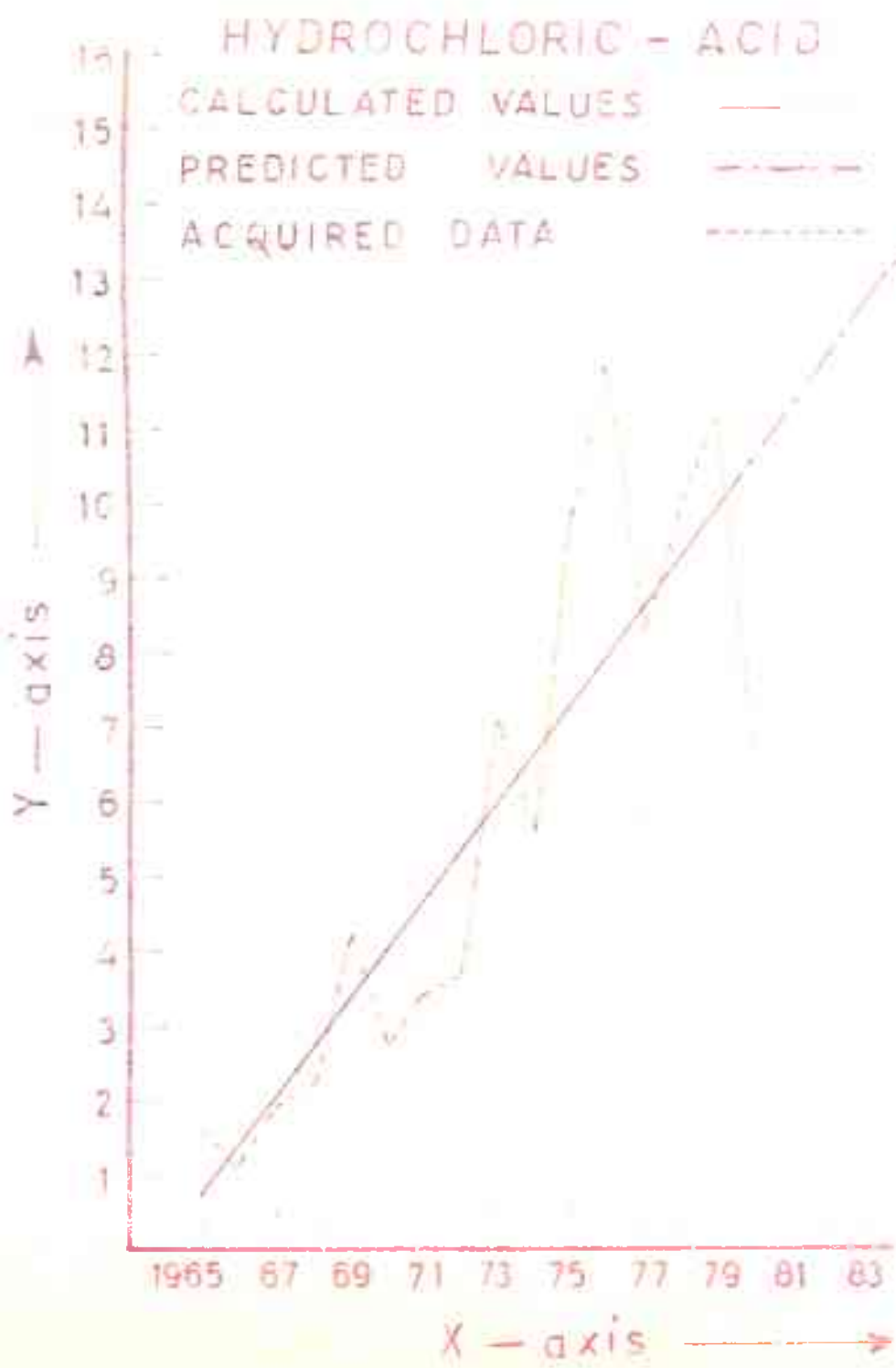
Chlorine produced as a by-product of caustic-soda manufacture is used by a variety of industries like textiles, pulp and paper and other chemical industries. The following paragraphs discuss the production trends in these industries and thus chlorine utilization and it demand.

HYDROCHLORIC ACID (Hcl)

Hydrochloric Acid production over the last fifteen years is marked with wide fluctuations (Table 5.4). The growth rate was as high as 94.3 pwr cent in 1973 while it was as low as -36.5 per cent in 1970. In spite of the large fluctuations hydrochloric acid production is steadily increasing. In 1965 the production was 33.43 thousand tons which came down to 23.85 thousand tons in 1966, showing a negative growth rate of -28.66 per cent. The succeeding four years saw a fourfold increase in production. By the end of seventies 198.7 thousand tons of Hcl was being produced in India. The same was the pattern of chlorine demanded in Hcl Production. In 1965 only 10 thousand tons of chlorine was demanded by the Hcl industry which became 59.6 thousand tons in 1978, showing a sixfold increase.

In spite of the large fluctuations, the growth pattern that can be filtered out from Tables 5.4 and 5.5 is that of a decreasing nature. Thus it can be said that the hydrochloric industry is growing but at a slower and slower rate. By the end of 1984 the tentative target for Hcl production, which will be achieved, will be low. Thus in the year 1984 the industry shall be requiring 79.16 thousand tons of chlorine, which shall increase only marginally for the coming years. If, however, the production growth of Hcl does not come to

a halt by the end of 1988, it will rise upto the level of 315.9 thousand tons and the chlorine demanded for the purpose will be 94.79 thousand tons. The growth rate of Hcl production in 1988 is expected to be 4.30 per cent as compared to the growth rate of 7.01 per cent in 1979.


HYDROCHLORIC - ACID
CALCULATED VALUES
PREDICTED VALUES
ACQUIRED DATA
Y — axis
X — axis
15
14
13
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10
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2
1
1965
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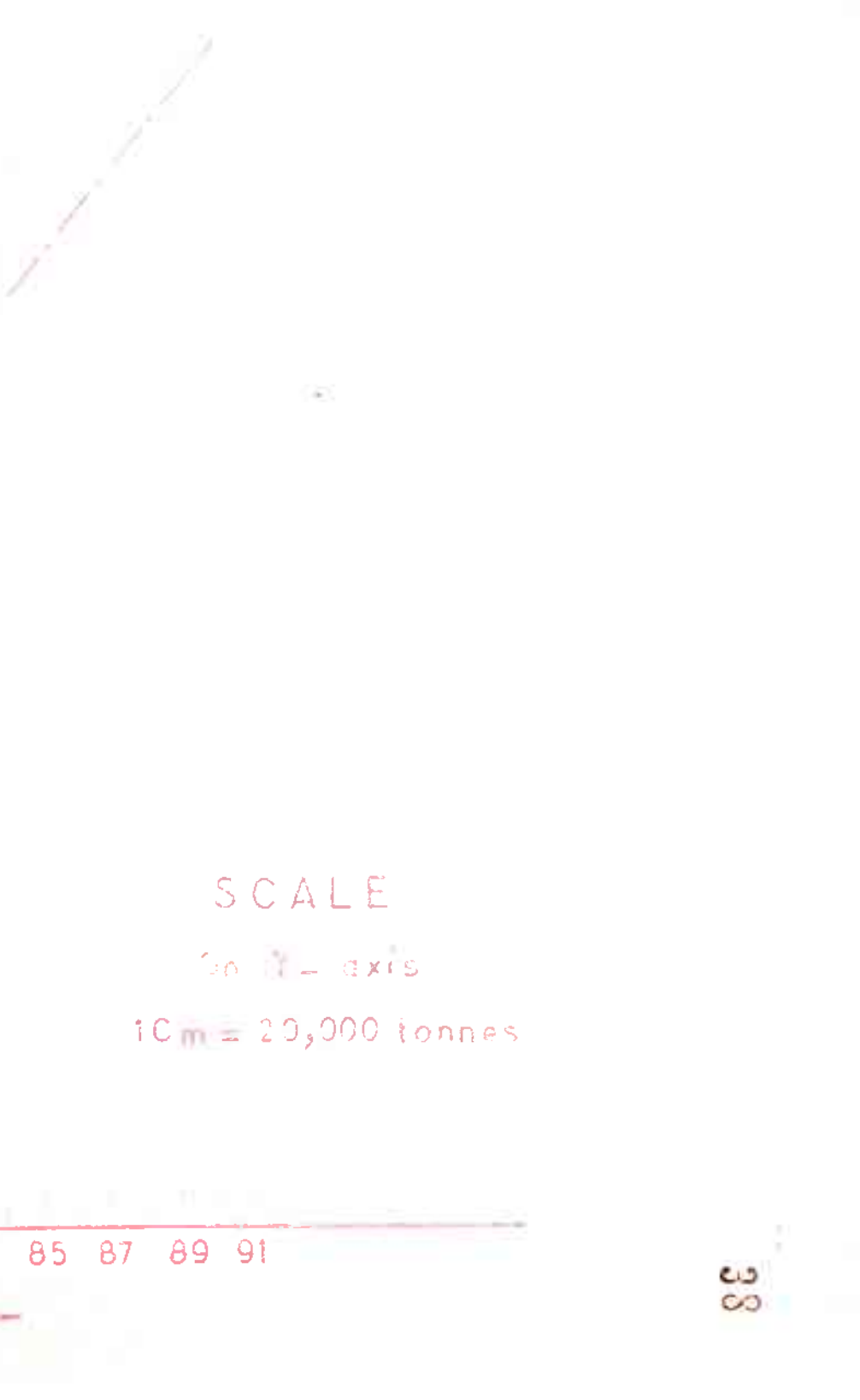

SCALE
On Y – axis
1Cm = 20,000 tonnes
85 87 89 91

TABLE 5.4A

HYDROCHLORIC ACID

CALCULATED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1965	16345.1	4903.5	--
1966	29372.9	8811.8	79.70
1967	42400.7	12720.2	44.35
1968	55428.5	16628.5	30.72
1969	68456.3	20536.8	23.50
1970	81484.1	24445.2	19.03
1971	94511.8	28353.5	15.98
1972	107539.6	32261.8	13.78
1973	120567.4	36170.2	12.11
1974	133595.2	40078.5	10.80
1975	146623.0	43986.8	9.75
1976	159650.8	47895.2	8.88
1977	172678.5	51803.5	8.16
1978	185706.3	55711.8	7.54
1979	198734.1	59620.2	7.01
1980	211761.9	63528.5	6.55
AVERAGE	114053.5	34216.0	19.86
STD. DEV.	62024.6	18607.3	19.56

THE CORRELATION CO-EFFICIENT IS 0.8649

F(1,14) IS 41.5809

THE CONFIDENCE INTERVAL IS 2020.3493

TABLE 5.5

HYDROCHLORIC ACID

PREDICTED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1981	224789.7	67436.9	6.15
1982	237817.5	71345.2	5.79
1983	250845.3	75253.5	5.47
1984	263873.1	79161.9	5.19
1985	276900.8	83070.2	4.93
1986	289928.6	86978.5	4.70
1987	302956.4	90886.9	4.49
1988	315984.2	94795.2	4.30
AVERAGE	270386.87	81116.04	5.13
STD. DEV.	31911.40	9573.41	0.64

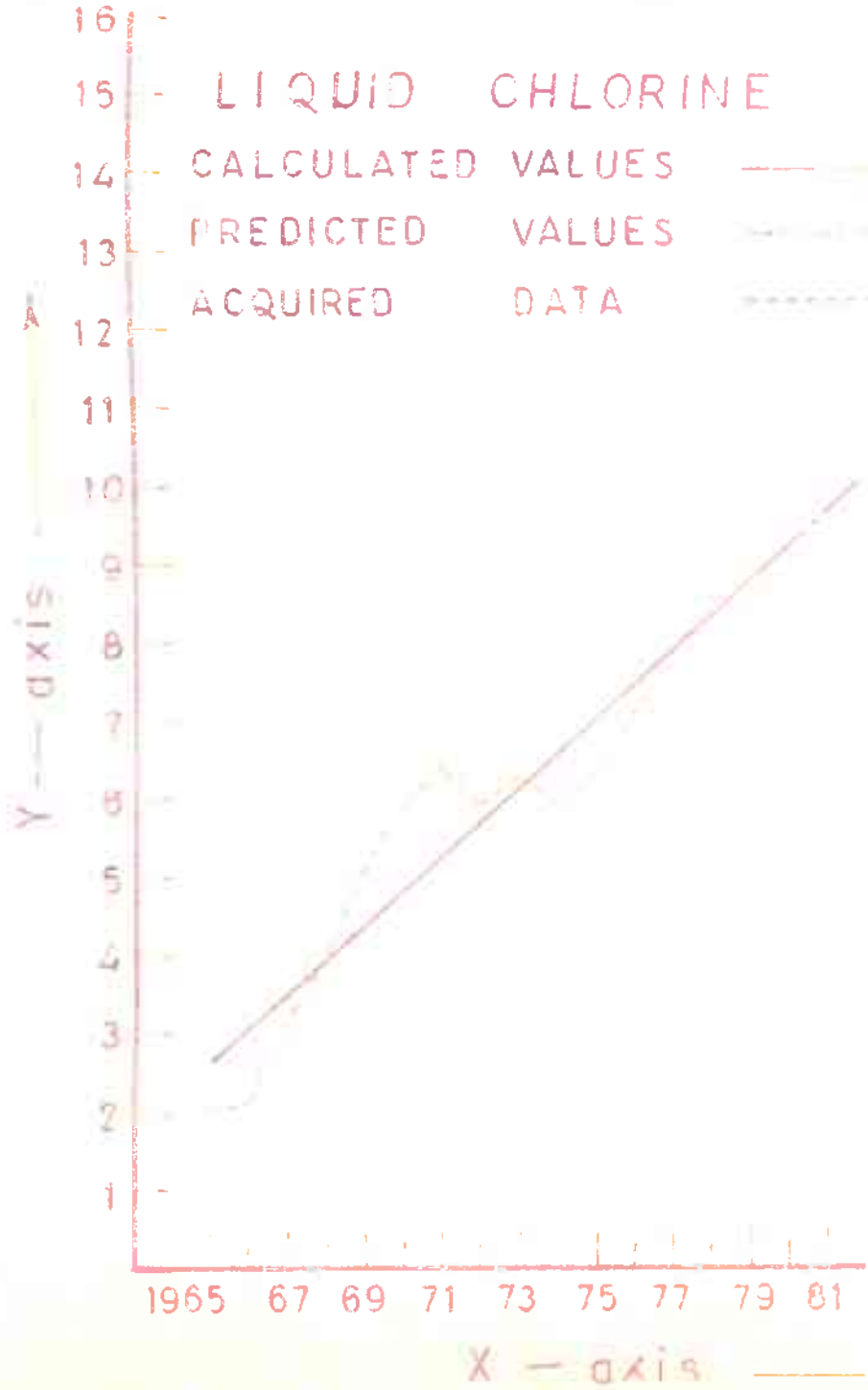
LIQUID CHLORINE

A large portion of chlorine produced is utilized by industries like textiles, rayon and pulp, etc. for bleaching purposes. All these industries use chlorine in the liquid form. Under this head we take into account the cumulative demand of all such industries. Thus, we don't have to forecast separately the demand for all those industries that use liquid chlorine. The utilization factor for liquid chlorine is 1.00

The production curve for liquid chlorine is a monotonic increasing one except for a few fluctuations in early seventies. The growth rate of liquid chlorine industry shows an initial increase which becomes almost maximum around 1969 and then starts decreasing. Thus, there was an accelerated growth in liquid chlorine production which lost its momentum in mid seventies. In 1965 the production of liquid chlorine was only 51.0 thousand tons which rose to 162.4 thousand tons in 1971 and further to 218.8 thousand tons in 1978.

There is as such no upper bound on liquid chlorine production. The only restriction is placed by the installed capacity which is 397.2 thousand tons. Thus, presently only 58.5 per cent installed capacity is being utilized. Full capacity utilization is not expected in this decade also but towards the end of this decade, in 1988, about 81.5

per cent of the installed capacity will be utilized. In 1981, 242.5 thousand tons of liquid chlorine would have been produced which would increase to 319.3 thousand tons 1988.


LIQUID CHLORINE
CALCULATED VALUES
PREDICTED VALUES
ACQUIRED DATA
Y — axis
X — axis
16
15
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4
3
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1
1965
67
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81

SCALE

On Y- axis

1 Cm = 25,000 tonnes

83 85 87 89 91

TABLE 5.6A

LIQUID CHLORINE

CALCULATED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1965	67220.8	67220.8	--
1966	78181.3	78181.3	16.30
1967	89141.8	89141.8	14.01
1968	100102.3	100102.3	12.29
1969	111062.8	111062.8	10.94
1970	122023.3	122023.3	9.86
1971	132983.8	132983.8	8.98
1972	143944.3	143944.3	8.24
1973	154904.8	154904.8	7.61
1974	165865.3	165865.3	7.07
1975	176825.8	176825.8	6.60
1976	187786.3	187786.3	6.19
1977	198746.8	198746.8	5.83
1978	209707.3	209707.3	5.51
1979	220667.8	220667.8	5.22
1980	231628.3	231628.3	4.96
AVERAGE	149424.5	149424.5	8.64
STD. DEV.	52182.4	52182.4	3.42

THE CORRELATION CO-EFFICIENT IS 0.9633

F(1,14) = 180.3915

THE CONFIDENCE INTERVAL IS 816.0767

BLE 5.7

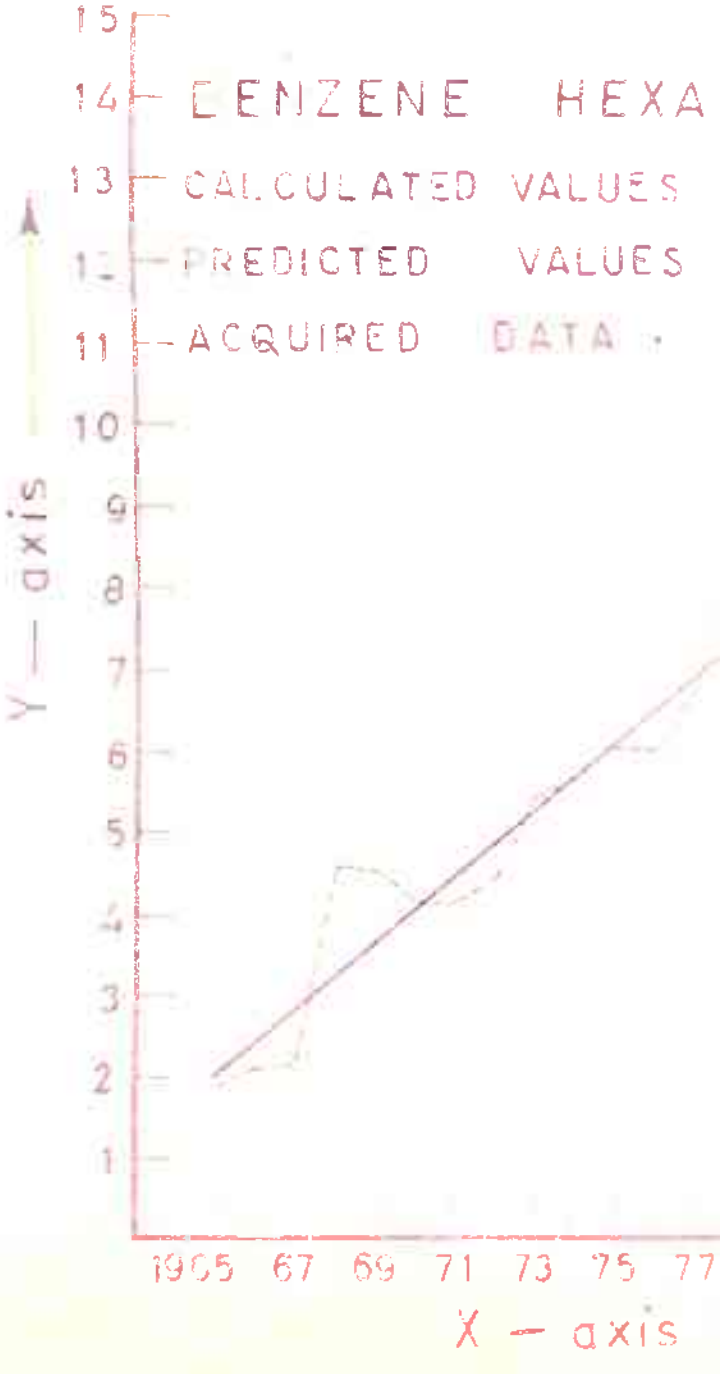
LIQUID CHLORINE

PREDICTED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1981	242588.8	242588.8	4.73
1982	253549.3	253549.3	4.51
1983	264509.8	264509.8	4.32
1984	275470.3	275470.3	4.14
1985	286430.8	286430.8	3.97
1986	297391.3	297391.3	3.82
1987	308351.8	308351.8	3.68
1988	319312.3	319312.3	3.55
AVERAGE	280950.56	280950.56	4.09
STD. DEV.	26847.62	26847.62	0.41

BENZENE HEXACHLORIDE (B.H.C.)

B.H.C. claimed around 6.9 thousand tons of chlorine in 1965 (Table 5.8). The production of B.H.C. increased from 7.4 thousand tons in 1965 to 33.6 thousand tons in 1978, thereby utilizing 30.27 thousand tons of chlorine in this year. There have been abrupt changes in B.H.C. production. For example, in 1968 its production shot up-to 18.18 thousand tons as compared to only 8.69 thousand tons in the previous year, a 109 per cent growth. B.H.C. production will also reach a steady state in eighties and then onwards there will only be marginal changes in B.H.C. production. However, in the event that new uses of B.H.C. are developed, causing an increase in its demand, the saturation level will be pushed further. In such a case the amount of B.H.C. production in 1981 would have been around 35 thousand tons which would increase to 45.8 thousand tons in 1988.


BENZENE HEXA
CALCULATED VALUES
PREDICTED VALUES
ACQUIRED DATA
Y — axis
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1965 67 69 71 73 75 77
X — axis

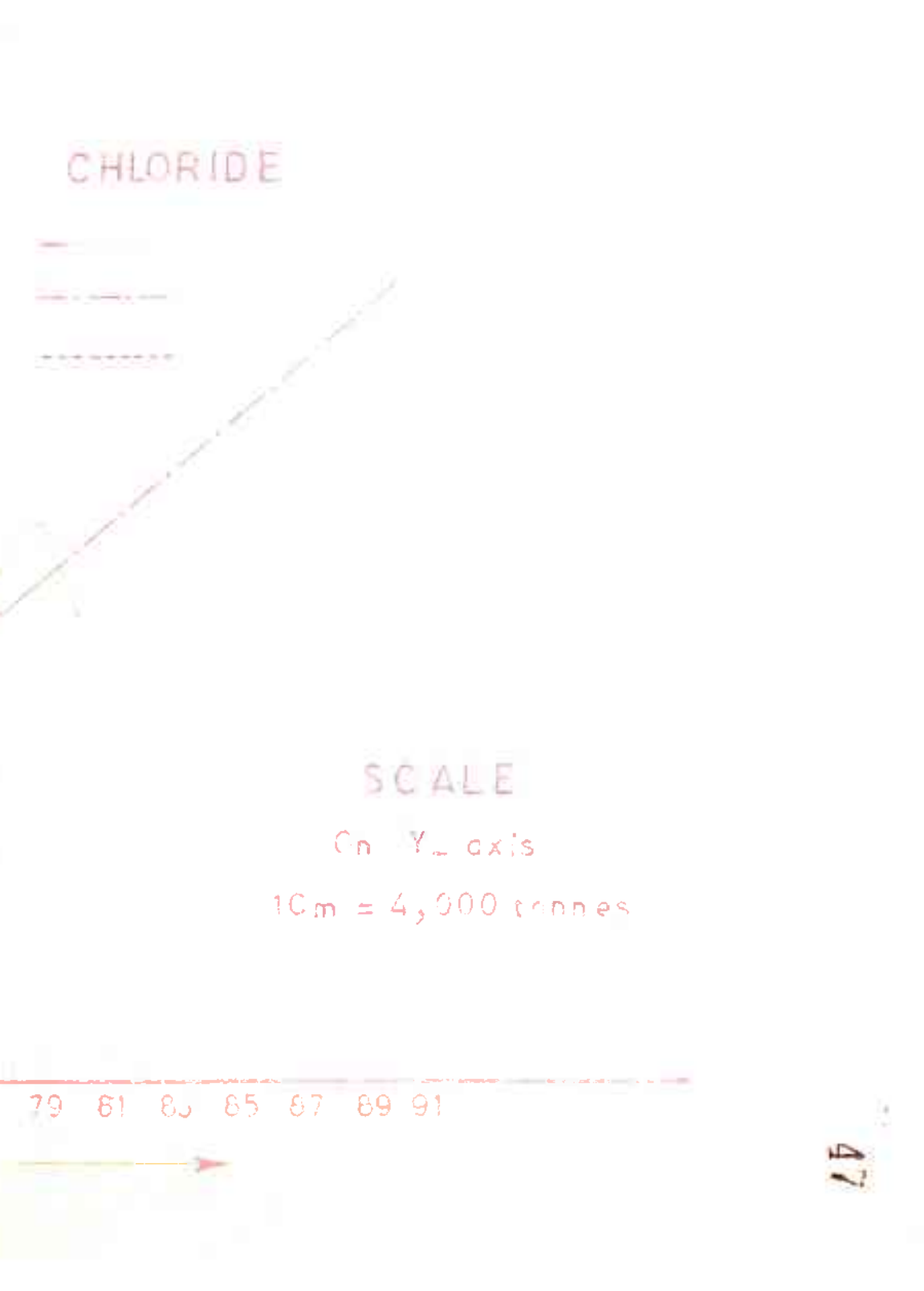

CHLORIDE
SCALE
On Y_ axis
1Cm = 4,000 tonnes
79 81 83 85 87 89 91

TABLE 5.8A

BENZENE HEXACHLORIDE

CALCULATED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1965	8185.2	7366.7	--
1966	9822.9	8840.6	20.00
1967	11460.6	10314.6	16.67
1968	13098.3	11788.5	14.28
1969	14736.0	13262.4	12.50
1970	16373.7	14736.3	11.11
1971	18011.4	16210.3	10.00
1972	19649.1	17684.2	9.09
1973	21286.8	19158.1	8.33
1974	22924.5	20632.0	7.69
1975	24562.2	22106.0	7.14
1976	26199.9	23579.9	6.66
1977	27837.6	25053.8	6.25
1978	29475.3	26527.8	5.88
1979	31113.0	28001.7	5.55
1980	32750.7	29475.6	5.26
AVERAGE	20467.9	19421.1	9.76
STD. DEV.	7796.99	7017.29	4.40

THE CORRELATION CO-EFFICIENT IS 0.9474

F(1,14) = 122.4812

THE CONFIDENCE INTERVAL IS 147.8603

TABLE 5.9

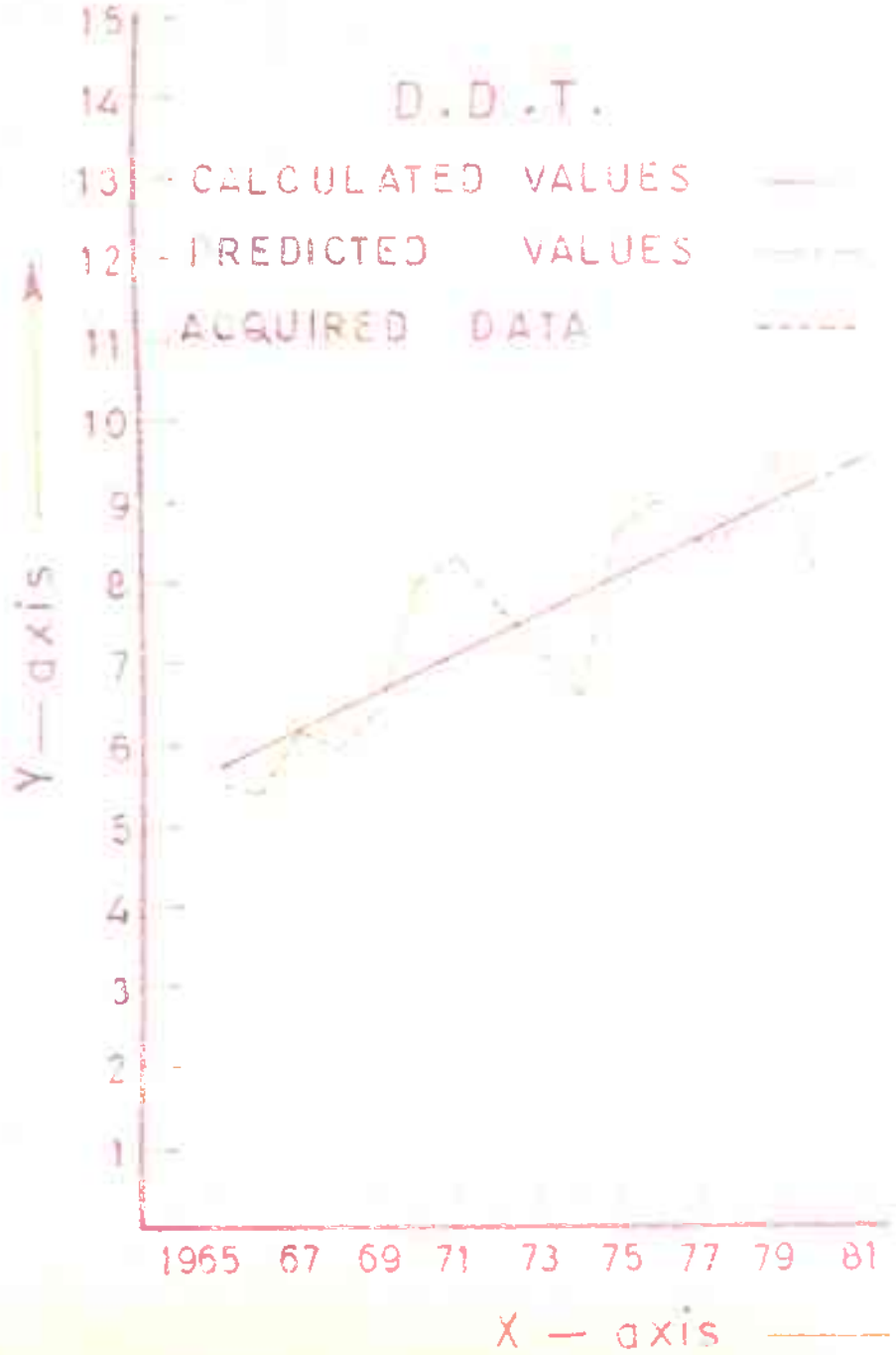
BENZENE HEXACHLORIDE

PREDICTED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1981	34388.4	30949.5	5.00
1982	36026.1	32423.5	4.76
1983	37563.8	33997.4	4.54
1984	39301.5	35371.3	4.34
1985	40939.2	36845.2	4.16
1986	42576.9	38319.2	4.00
1987	44214.6	39793.1	3.84
1988	45852.3	41267.0	3.70
AVERAGE	40120.35	36108.32	4.29
STD. DEV.	4011.52	3610.36	0.45

D. D. T.

The past statistics show that there have been wide fluctuations in the growth pattern of D.D.T. production, varying from a growth rate of -7.0 per cent in 1974 to a growth rate of 31.16 per cent in 1975. In 1965 D.D.T. production was 2745 tons which remained almost the same during the next year. There was a sudden increase in its production in 1970. Towards the end of seventies this industry was utilizing 6.4 thousand tons of chlorine. It is envisaged that with the industrial growth D.D.T. production will also increase and by the end of 1988 it is expected to rise to about 5.7 thousand tons and it will be utilizing 8.6 thousand tons of chlorine. But the growth rate of D.D.T. industry in eighties will be only marginal with a growth rate of about 2.53 per cent in 1981 and 2.15 per cent in 1988.


D.D.T.
CALCULATED VALUES
PREDICTED VALUES
ACQUIRED DATA
Y — axis
X — axis
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4
3
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1965
67
69
71
73
75
77
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81

SCALE

On Y_ axis

1Cm = 500 tonnes

83 85 87 89 91

TABLE 5.10A

D.D.T.

CALCULATED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1965	2870.6	4306.0	--
1966	2987.9	4481.8	4.08
1967	3105.1	4657.6	3.92
1968	3222.3	4833.5	3.77
1969	3339.5	5009.3	3.63
1970	3456.8	5185.2	3.51
1971	3574.0	5361.0	3.39
1972	3691.2	5536.8	3.27
1973	3808.4	5712.7	3.17
1974	3925.7	5888.5	3.07
1975	4042.9	6064.4	2.98
1976	4160.1	6240.2	2.89
1977	4277.3	6416.0	2.81
1978	4394.6	6591.9	2.74
1979	4511.8	6767.7	2.66
1980	4629.0	6943.6	2.59
AVERAGE	3749.87	5624.81	3.23
STD. DEV.	558.10	837.16	0.47

THE CORRELATION CO-EFFICIENT IS 0.8485

F(1,14) = 35.9974

THE CONFIDENCE INTERVAL IS 19.5395

TABLE 5.11

D.D.T.

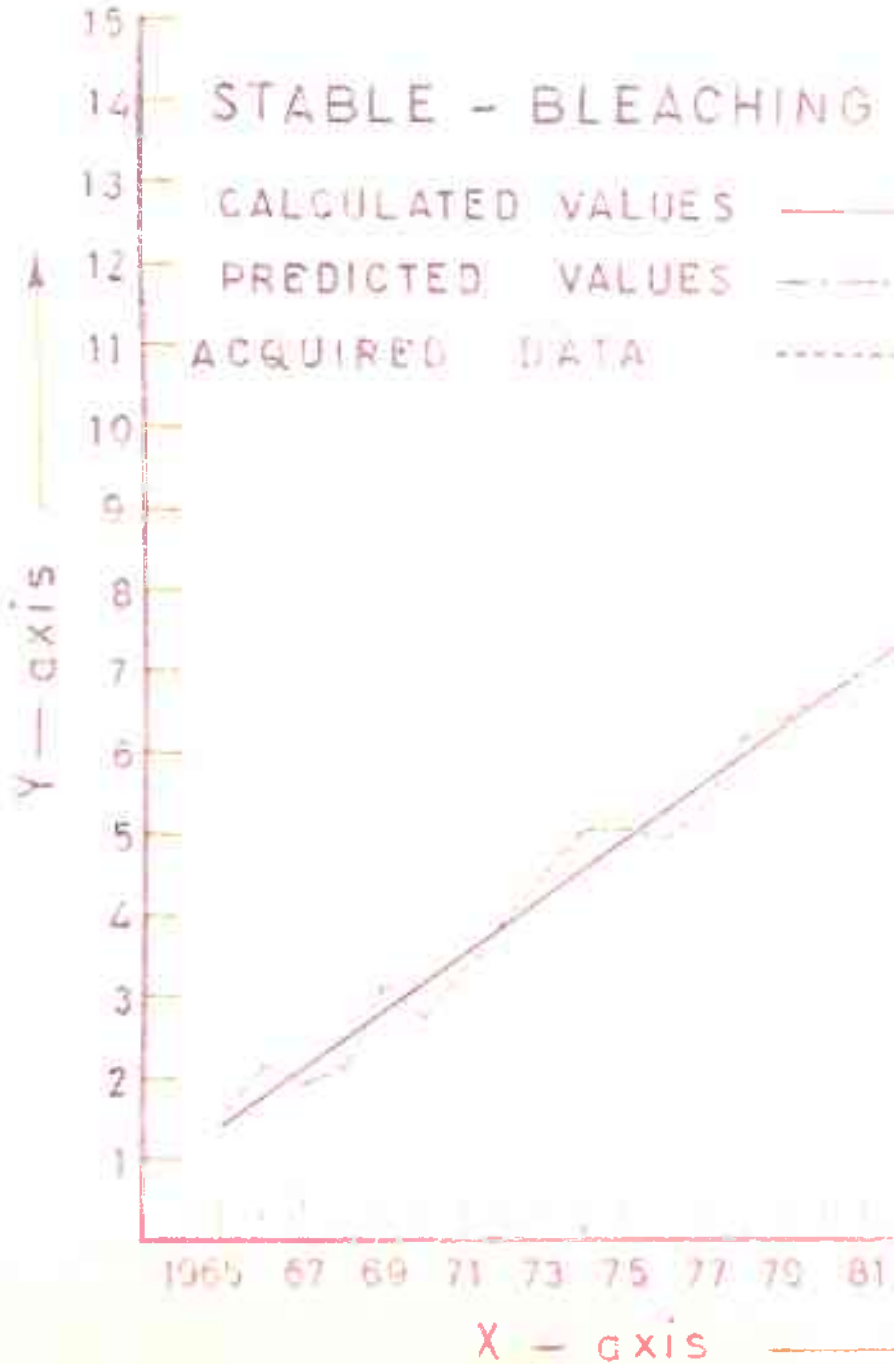
PREDICTED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1981	4746.3	7119.4	2.53
1982	4863.5	7295.2	2.46
1983	4980.7	7471.1	2.41
1984	5097.9	7646.9	2.35
1985	5215.2	7822.8	2.29
1986	5332.4	7998.6	2.24
1987	5449.6	8174.4	2.19
1988	5566.8	8350.3	2.15
AVERAGE	5156.59	7734.88	2.33
STD. DEV.	287.14	430.71	0.13

STABLE BLEACHING POWDER

In early sixties stable bleaching powder was utilising in its manufacture only a small fraction of totcal chlorine produced in India. In the year 1965, 7.35 tons of the stable bleaching powder was produced which utilized only 2.9 thousand tons of chlorine. But in the coming year its production increased to the level of 10.80 thousand tons, a 46.8 per cent growth over the previous year. By the end of 1978, stable bleaching powder was one of the major chlorine consuming industry. In 1978, stable bleaching powder was produced to the tune of 30.9 thousand tons which utilized 12.36 thousand tons of chlorine.

By the end of 1980 the tentative target for stable bleaching powder would have been achieved. Then onwards the growth in this industry will be very slow. The production is expected to stabilize at around 48 thousand tons. By the end of 1988 the production is expected to reach the level of 47.8 thousand tons. At that time the growth rate is expected to be only 3.8 per cent and the industry will be consuming 18.99 thousand tons of chlorine.


STABLE - BLEACHING
CALCULATED VALUES
PREDICTED VALUES
ACQUIRED DATA
Y — axis
X — axis
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
1965
67
69
71
73
75
77
79
81


POWDER
SCALE
1Cm = 5,000 tonne
83 85 87 89 91

TABLE 5.12A

STABLE BLEACHING POWDER

CALCULATED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE UTILISATION	GROWTH-RATE (PERCENTAGE)
1965	6954.9	2781.9	--
1966	8731.2	3492.4	25.53
1967	10507.4	4202.9	20.34
1968	12283.6	4913.4	16.90
1969	14059.8	5623.9	14.46
1970	15836.0	6334.4	12.63
1971	17612.3	7044.9	11.21
1972	19388.5	7755.4	10.08
1973	21164.7	8465.8	9.16
1974	22940.9	9176.3	8.39
1975	24717.1	9886.8	7.74
1976	26493.3	10597.3	7.18
1977	28269.6	11307.8	6.70
1978	30045.8	12018.3	6.28
1979	31822.0	12728.8	5.91
1980	33598.2	13439.3	5.58
AVERAGE	20276.62	8110.64	11.20
STD. DEV.	8456.48	3382.59	5.85

THE CORRELATION CO-EFFICIENT IS 0.9952

F(1,14) = 465.5099

THE CONFIDENCE INTERVAL IS 82.3304

TABLE 5.13

STABLE BLEACHING POWDER

PREDICTED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1981	35374.4	14149.7	5.28
1982	37150.6	14860.2	5.02
1983	38926.9	15570.7	4.78
1984	40703.1	16281.2	4.56
1985	42479.3	16991.7	4.36
1986	44255.5	17702.2	4.18
1987	46031.7	18412.7	4.01
1988	47808.0	19123.1	3.85
AVERAGE	41591.22	16636.48	4.50
STD. DEV.	4350.82	1740.33	0.49

POLYVINYL CHLORIDE (P.V.C.)

P.V.C. industry has come up as one of the major chlorine consuming industry and with the increased uses of P.V.C. the industry will utilize more and more of chlorine in near future. The tentative target in 1983 for P.V.C. production is 75.3 thousand tons. On the basis of the forecast we can say that the present target will be achieved by 1983-84.

In 1965, P.V.C. production was only 12.17 thousand tons which decreased to 10.79 thousand tons in the very next year. P.V.C. at that time was demanding only 8.1 thousand tons of chlorine. But gradually the P.V.C. production increased demanding more and more of chlorine in the succeeding years. In 1969, there was a growth rate of 92.4 per cent in chlorine utilization by P.V.C. industry which rose to 25.39 thousand tons from a value of 13.19 thousand tons in the previous year. By the end of 1978, 59.0 thousand tons of P.V.C. was produced utilizing 44.3 thousand tons of chlorine.

With the increased and varied applications of P.V.C. it is very likely that the present target for P.V.C. production may have to be revised. In that case the saturation level which is expected to come in 1983-84 will be delayed. If the present growth trend in P.V.C. industry prevails, by the end of 1988, the industry will be utilizing 73 to 75 thousand tons of chlorine. P.V.C. industry is poised to emerge as one of the major chlorine utilizing industries in the near future.

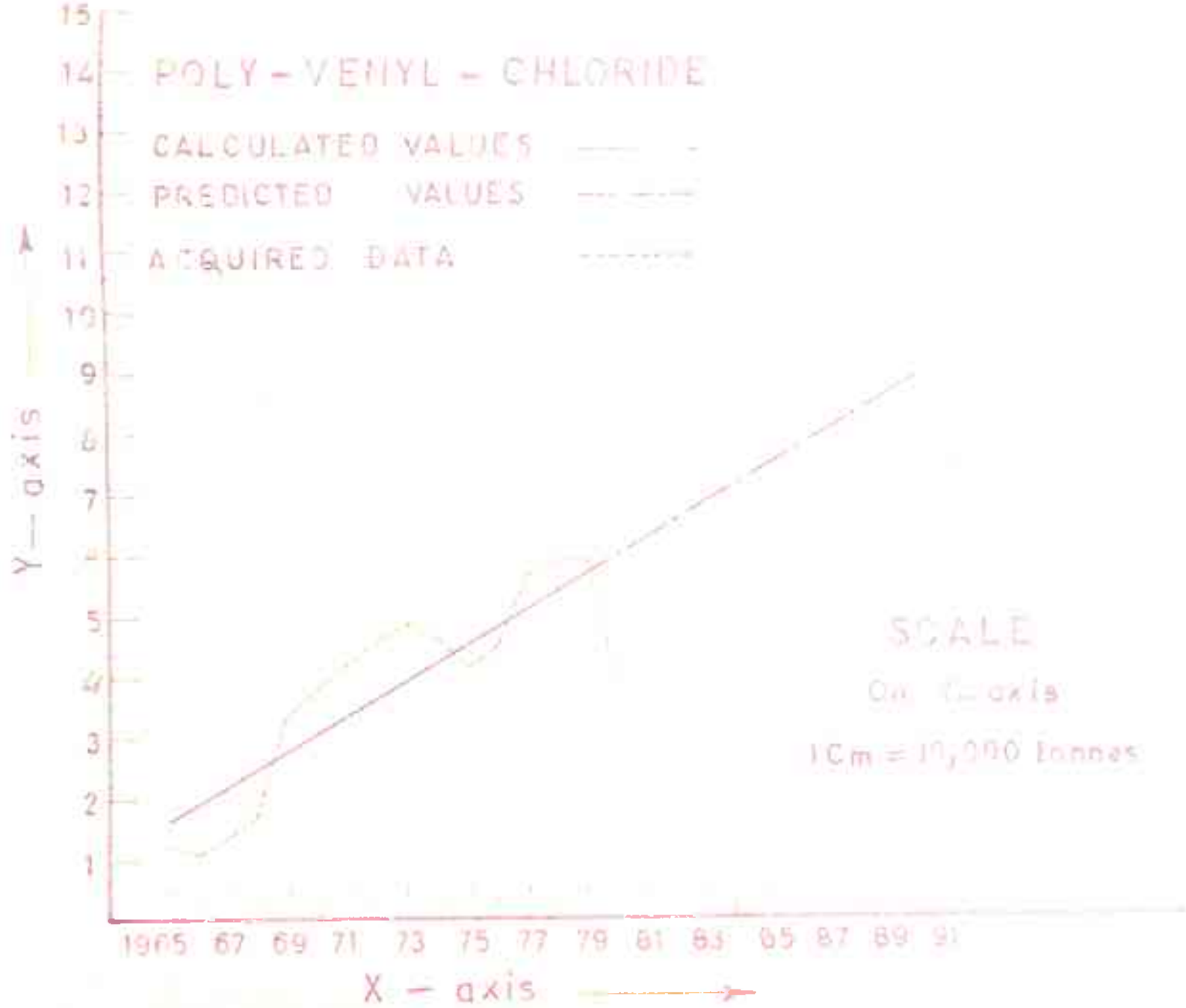

POLY - VENYL - CHLORIDE
CALCULATED VALUES
PREDICTED VALUES
ACQUIRED DATA
Y — axis
X — axis
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
1965 67 69 71 73 75 77 79 81 83 85 87 89 91
SCALE
On Y — axis
1Cm = 10,000 tonnes

TABLE 5.14A

POLYVINYL CHLORIDE

CALCULATED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1965	16281.9	12211.4	--
1966	19206.6	14404.9	17.96
1967	22131.2	16598.4	15.22
1968	25055.9	18791.9	13.21
1969	27980.5	20985.4	11.67
1970	30905.2	23178.9	10.45
1971	33829.8	25372.3	9.46
1972	36754.5	27565.8	8.64
1973	39679.1	29759.3	7.95
1974	42603.7	31952.8	7.37
1975	45528.4	34146.3	6.86
1976	48453.0	36339.8	6.42
1977	51377.7	38533.2	6.03
1978	54302.3	40726.7	5.69
1979	57226.9	42920.2	5.38
1980	60151.6	45113.7	5.11
AVERAGE	38216.80	28662.59	9.16
STD. DEV.	13924.07	10443.05	3.86

THE CORRELATION CO-EFFICIENT IS 0.8483

F(1,14) = 35.9506

THE CONFIDENCE INTERVAL IS 487.7775

TABLE 5.15

POLYVINYL CHLORIDE

PREDICTED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1981	63076.2	47307.2	4.86
1982	66000.9	49500.6	4.63
1983	68925.5	51694.1	4.43
1984	71850.2	53887.6	4.24
1985	74774.8	56081.1	4.07
1986	77699.5	58274.6	3.91
1987	80624.1	60468.1	3.76
1988	83548.7	62661.5	3.62
AVERAGE	73312.51	54984.38	4.19
STD. DEV.	7163.68	5372.91	0.43

PHOSPHORUS TRICHLORIDE (PCl_3)

As far as chlorine utilization is concerned this industry utilizes only small quantity. In 1965 only 200 tons of phosphorus trichloride was produced consuming only 154 tons of chlorine, a very small fraction of total chlorine produced. Its production steadily increased and increased from this small value to the tune of 2.25 thousand tons in 1978. The maximum growth rate in this industry occured in 1970 when its production increased from 316 tons to 786 tons, a growth rate of 148.7 per cent. The tentative production target for phosphorus trichloride is 2600 tons which is expected to be achieved by 1983. In steady state 2754 tons of phosphorus trichloride shall be produced which will utilize 2120.80 tons of chlorine.

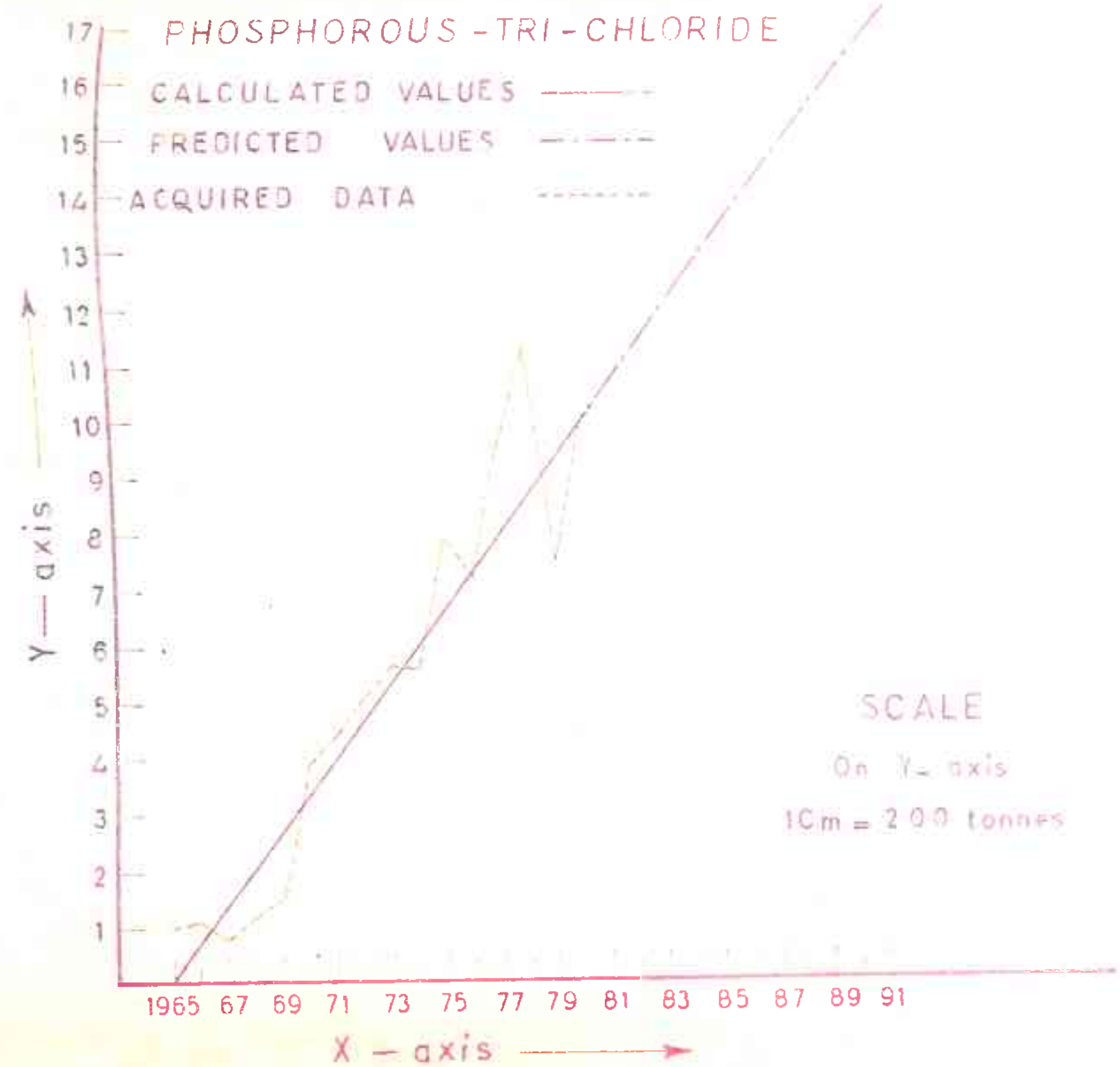

PHOSPHOROUS - TRI - CHLORIDE
CALCULATED VALUES
PREDICTED VALUES
ACQUIRED DATA
Y — axis
X — axis
1965 67 69 71 73 75 77 79 81 83 85 87 89 91
SCALE
On Y- axis
1Cm = 200 tonnes

TABLE 5.16A

PHOSPHORUS TRICHLORIDE

CALCULATED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1965	7.5	5.8	--
1966	146.4	112.7	1829.23
1967	285.2	219.6	94.81
1968	424.0	326.5	48.66
1969	562.8	433.3	32.73
1970	701.6	540.2	24.66
1971	840.4	647.1	19.78
1972	979.2	754.0	16.51
1973	1118.0	860.9	14.17
1974	1256.9	967.8	12.41
1975	1395.7	1074.7	11.04
1976	1534.5	1181.5	9.94
1977	1673.3	1288.4	9.04
1978	1812.1	1395.3	8.29
1979	1950.9	1502.2	7.66
1980	2089.7	1609.1	7.11
AVERAGE	1048.68	807.48	143 .07
STD. DEV.	660.88	508.87	467.02

THE CORRELATION CO-EFFICIENT IS 0.9512

F(1,14) = 133.3140

THE CONFIDENCE INTERVAL IS 12.0226

TABLE 5.17

PHOSPHORUS TRICHLORIDE

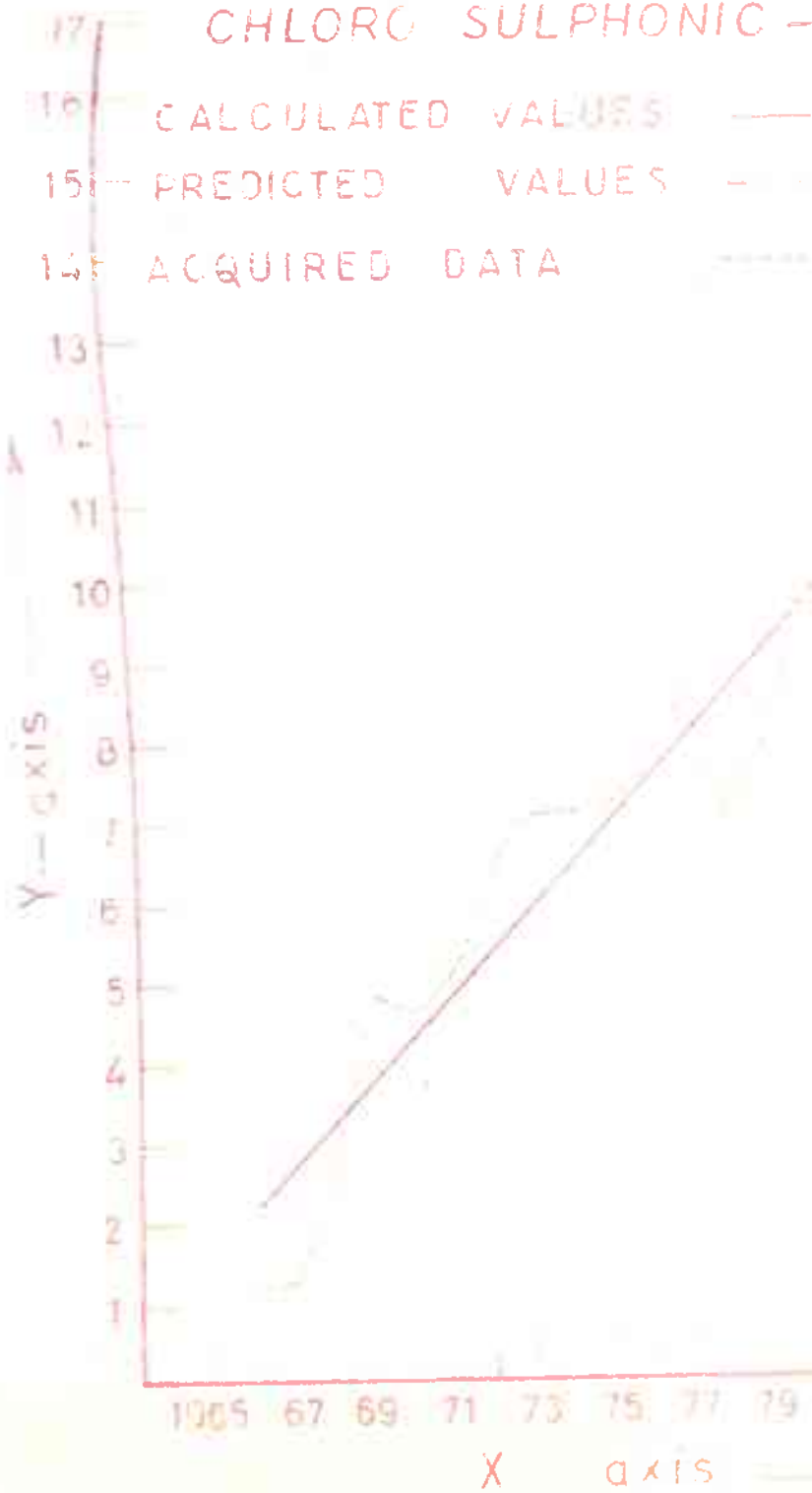
PREDICTED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1981	2228.6	1716.0	6.64
1982	2367.4	1822.9	6.22
1983	2506.2	1929.7	5.86
1984	2645.0	2036.6	5.53
1985	2783.8	2143.5	5.24
1986	2922.6	2250.4	4.98
1987	3061.4	2357.3	4.74
1988	3200.2	2464.2	4.53
AVERAGE	2714.44	2090.12	5.47
STD. DEV.	340.02	261.81	0.73

CHLOROSULPHONIC ACID

About 2.5 thousand tons of chlorosulphonic acid was produced in 1966. From then onwards its production has been increasing with retarded growth rate. In 1972 the growth rate was 26.3 per cent which gradually came down to 12 per cent in 1978 while its production rose from 2.5 thousand tons to 17.1 thousand tons. The same is the profile of increase of chlorine utilized by the industry which increased from 756 tons in 1966 to around 5.7 thousand tons in 1980.

A forecast on this statistics which is corelated to the given data shows 93.4 per cent corelation. This implies that by the end of 1981 this industry would have been utilizing 6.0 thousand tons of chlorine. Throughout this decade chlorosulphonic acid industry will be showing a growing trend. The target for this industry which is tentatively fixed at 32.4 thousand tons will not be reached in this decade. By the end of 1988, chlorine utilization by this industry will be of the level of 8.3 thousand tons but the growth rate will be only 3.97 per cent which indicates a near saturation situation towards the end of eighties.


CHLORO SULPHONIC –
CALCULATED VALUES
PREDICTED VALUES
ACQUIRED DATA
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Y - axis
1965
67
69
71
73
75
77
79
X axis


ACID
SCALE
On Y_axis
10mm=2,000 tonnes
81
87
89
91

TABLE 5.18A

CHLOROSULPHONIC ACID

CALCULATED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1966	4403.3	1321.0	--
1967	5462.2	1638.6	24.04
1968	6521.1	1956.3	19.38
1969	7580.0	2274.0	16.23
1970	8638.9	2591.6	13.96
1971	9697.8	2909.3	12.25
1972	10756.7	3227.0	10.91
1973	11815.6	3544.6	9.8
1974	12874.5	3862.3	8.96
1975	13933.4	4180.0	8.22
1976	14992.3	4497.7	7.59
1977	16051.2	4815.3	7.06
1978	17110.1	5133.0	6.59
1979	18169.0	5450.7	6.18
1980	19227.9	5768.3	5.82
AVERAGE	11815.66	3544.69	11.22
STD. DEV.	4735.53	1420.65	5.45

THE CORRELATION CO-EFFICIENT IS 0.9340

F(1,13) = 88.9487

THE CONFIDENCE INTERVAL IS 112.2764

TABLE 5.19

CHLOROSULPHONIC ACID

PREDICTED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1981	20286.8	6086.0	5.50
1982	21345.7	6403.7	5.21
1983	22404.6	6721.3	4.96
1984	23463.5	7039.0	4.72
1985	24522.4	7356.7	4.51
1986	25581.3	7674.4	4.31
1987	26640.2	7992.0	4.13
1988	27699.1	8309.7	3.97
AVERAGE	23993.00	7197.89	4.66
STD. DEV.	2593.76	778.12	0.53

MONOCHLORO ACETIC ACID

Chlorine consumption in the production of monochloro acetic acid is marked with very wide fluctuations. In 1966, it utilized 245.8 tons of chlorine which further fell to only 16 tons in the next very year showing a fall of 93.2 per cent. In 1968, there was a tremendous growth in this industry, as much as the production attained the level of 1083 tons showing 2361 per cent increase. In the succeeding years the production steadily increased and by the end of 1976 this industry was using 1.38 thousand tons of chlorine. At this rate it is expected that the industry will achieve its target by the end of 1983 when it will be utilizing 2551 tons of chlorine. On the other hand, if the demand for the acid continues to grow even at the same rate by the end of 1988 this industry shall be demanding 3273 tons of chlorine. The growth rate is expected to decrease from 6.8 per cent in 1981 to 4.61 per cent in 1988.

MONOCHLORO ACETIC ACID
CALCULATED VALUES
PREDICTED VALUES
ACQUIRED DATA
SCALE
On Y- axis
1Cm = 300 tonnes
Y — axis
X — axis
1965 67 69 71 73 75 77 79 81 83 85 87 89 91

TABLE 5.20A

MONOCHLORO ACETIC ACID

CALCULATED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1966	252.2	95.8	--
1967	632.3	240.2	150.66
1968	1012.4	384.7	60.10
1969	1392.5	529.1	37.54
1970	1772.6	673.5	27.29
1971	2152.6	818.0	21.44
1972	2532.7	962.4	17.65
1973	2912.8	1106.8	15.00
1974	3292.9	1251.3	13.04
1975	3673.0	1395.7	11.54
1976	4053.0	1540.1	10.34
1977	4433.1	1684.6	9.37
1978	4813.2	1829.0	8.57
AVERAGE	2932.76	962.45	31.88
STD. DEV.	1480.20	562.47	40.26

THE CORRELATION CO-EFFICIENT IS 0.9587

F(1,11) = 125.0516

THE CONFIDENCE INTERVAL IS 33.9888

CARBON TETRACHLORIDE (CCl_4)

Only a limited data is available for this industry. On the basis of the production profile it is evident that the industry is growing. But the growth rate does not reveal any pattern.It oscilates between a maximum of 75.7 per cent in 1969 and -3.9 per cent in 1973. The forecast shows that the industry will grow further in the coming years. It will be utilizing 2208 tons of chlorine in 1981 which will increase to 3027.5 tons by the end of this decade. The growth rate is expected to show a steady marginal decline, from a value of 5.5 per cent in 1981 to a value of 4.01 per cent in 1988.

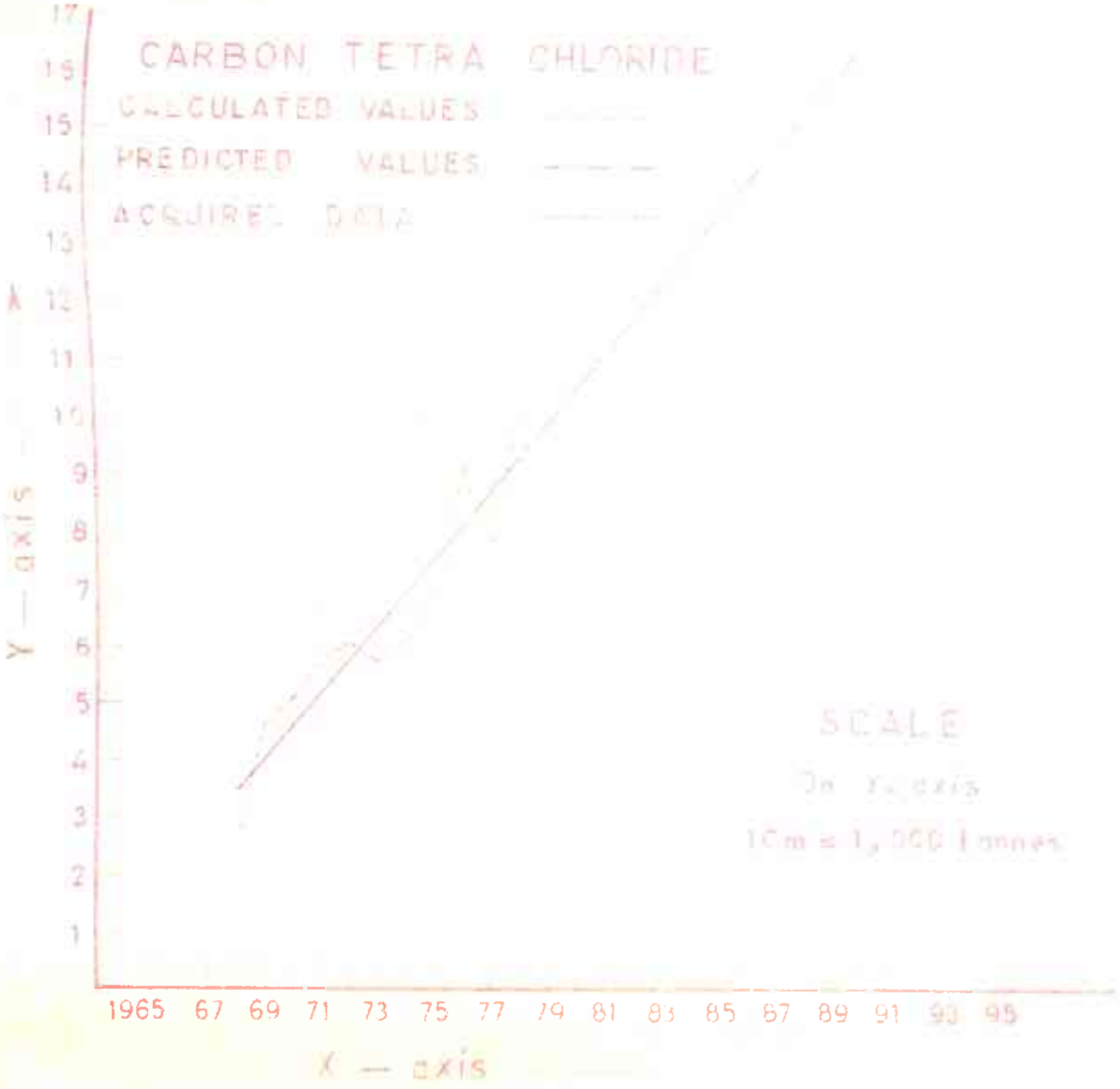

CARBON TETRA CHLORIDE
CALCULATED VALUES
PREDICTED VALUES
ACQUIRED DATA
Y — axis
X — axis
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
1965 67 69 71 73 75 77 79 81 83 85 87 89 91 93 95
SCALE
On X axis
1Cm = 1,000 tonnes

TABLE 5.22A

CARBON TETRACHLORIDE

CALCULATED VALUES

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1968	3439.2	687.8	--
1969	4023.2	804.6	17.01
1970	4608.2	921.6	14.53
1971	5193.2	1038.6	12.69
1972	5778.2	1155.6	11.26
1973	6363.1	1272.6	10.12
1974	6948.1	1389.6	9.19
1975	7533.1	1506.6	8.41
1976	8118.1	1623.6	7.76
1977	8703.1	1740.6	7.20
1978	9288.0	1857.6	6.72
AVERAGE	6363.17	1272.63	10.49
STD. DEV.	1940.16	388.03	3.38

THE CORRELATION CO-EFFICIENT IS 0.9316

F(1, 9) = 59.1751

THE CONFIDENCE INTERVAL IS 76.0460

TABLE 5.23

CARBON TETRACHLORIDE

PREDICTED VALUES

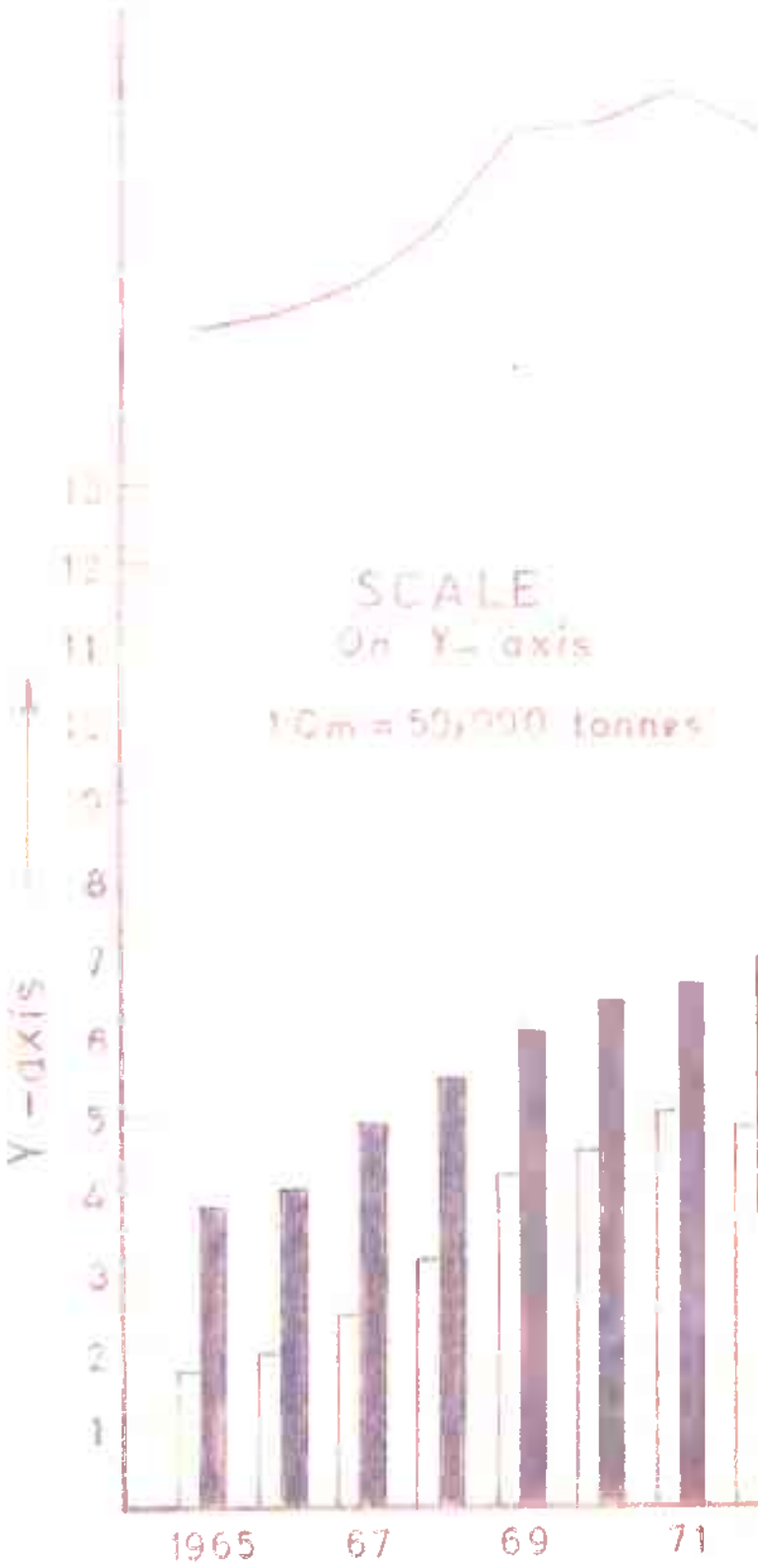
YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1979	9873.0	1974.6	6.29
1980	10458.0	2091.6	5.92
1981	11043.0	2208.6	5.59
1982	11628.0	2325.6	5.29
1983	12212.9	2442.5	5.03
1984	12797.9	2559.5	4.78
1985	13382.9	2676.5	4.57
1986	13967.9	2793.5	4.37
1987	14552.9	2910.5	4.18
1988	15137.9	3027.5	4.01
AVERAGE	12505.48	2501.09	5.00
STD. DEV.	1771.11	354.22	0.76

CHLORINE AVAILABILITY AND UTILIZATION

Table 5.24 shows chlorine availability and utilization from the year 1965 to 1978. In the beginning only 46.4 per cent of chlorine was utilized. In 1966 the chlorine utilization became 94597.8 tons from 84113.7 tons in 1965, showing a growth rate of 12.4 per cent. Chlorine supply also increased during the same period from 189160.4 tons to 202803.9 tons indicating a growth of 7.21 per cent. Thus we see that right from the beginning the chlorine consuming industries have been growing faster than the caustic-soda industry, which yields chlorine. The utilization factor in 1966 improved marginally at 46.6 per cent. There was 37.13 per cent growth in chlorine consuming industries while the supply increased only by 13.24 per cent in 1969. Thus we can say that the chlorine utilization is catching up with chlorine production. In 1978, 432.2 thousand tons of chlorine was produced while 334.5 thousand tons of chlorine was utilized, a utilization factor of 79.1 per cent as against 44.4 per cent in the year 1965.

With the growth of industrialisation, as has been observed in many other countries, in India also the chlorine utilization factor will improve and will approach unity. A time will come when the caustic-soda industry will grow only marginally. Such a situation will arise around 1983 and

chlorine availability will reach a steady state value of 573.6 thousand tons. At the same time the chlorine consuming industries will keep on growing. In 1981 itself 532.12 thousand tons of chlorine would have been produced while 421.82 thousand tons was expected to have been effectively utilized which is about 79.2 per cent. The actual problem will be evident in 1987-88 when the demand for chlorine will become 562.58 thousand tons reaching the utilization factor of 83.0 per cent. Keeping in mind the unaccounted block, at that time any further increase in chlorine requirements to be met by the same method would mean a surplus caustic-soda production posing a serious problem of marketing. Also, if the chlorine production is not increased, it will mean hampering nation's industrial growth. This requires planning in advance to meet the expected situation effectively.


SCALE
On Y- axis
1 Cm = 50,000 tonnes
Y - axis
1
2
3
4
5
6
7
8
11
12
1965
67
69
71


PERCENTAGE UTILIZATION
73
75
77
81
83
85
87
X - axis

TABLE 5.24

TOTAL CHLORINE AVAILABILITY AND UTILIZATION
ACQUIRED DATA

YEAR	AVAILABILITY	UTILIZATION	PERCENTAGE UTILIZATION
1965	189160.40	84113.73	44.46
1966	202803.93	94597.81	46.64
1967	237020.96	119645.54	50.47
1968	269197.31	154666.12	57.45
1969	304840.81	212100.09	69.57
1970	318076.00	223978.93	70.41
1971	331437.93	248516.81	74.98
1972	344148.68	240506.93	69.88
1973	361278.75	279231.12	77.28
1974	379764.00	258314.25	68.01
1975	389540.81	297708.68	76.42
1976	443608.00	332337.06	74.91
1977	454960.00	344442.93	75.70
1978	482240.00	381714.62	79.15

TABLE 5.25

TOTAL CHLORINE AVAILABILITY AND UTILIZATION

PREDICTED VALUES

YEAR	AVAILABILITY	UTILIZATION	PERCENTAGE UTILIZATION
1979	490595.87	381607.37	77.78
1980	511359.43	401716.00	78.55
1981	532123.00	421824.56	79.27
1982	552886.62	441933.06	79.93
1983	573650.12	462041.68	80.54
1984	594413.75	482150.18	81.11
1985	615177.25	502258.68	81.64
1986	635940.87	522367.31	82.14
1987	656704.50	542475.75	82.60
1988	677468.00	562584.25	83.04

CROSS-CORRELATION BETWEEN CAUSTIC-SODA SUPPLY AND CHLORINE CONSUMING INDUSTRIES

Presently caustic-soda production is the only source of mass chlorine production. Many industries like Hcl, Liquid Chlorine, B. H. C., P. V. C., etc. share the chlorine so produced. Naturally, we expect a certain degree of correlation between caustic-soda production and production of these items. Table 2.27 lists the cross-correlation metrix for these items. As expected caustic-soda is highly correlated to almost all these items.

TABLE 5.26

CROSS CORRELATION MATRIX

Caustic Soda	HCl	Liq. Cl_2	BHC	DDT	SBP	PVC	PCl_3	Chloro Sulph. A.	Mono Chl. A.A.	CCl_4	
1.00	0.90	0.86	0.81	0.69	0.91	0.74	0.90	0.92	0.92	0.96	Caustic Soda
0.90	1.00	0.71	0.89	0.61	0.82	0.49	0.79	0.80	0.74	0.85	HCl
0.86	0.71	1.00	0.48	0.85	0.74	0.86	0.85	0.81	0.91	0.92	Liquid Chlorine
0.81	0.89	0.48	1.00	0.32	0.87	0.40	0.74	0.33	0.64	0.65	BHC
0.69	0.61	0.85	0.32	1.00	0.46	0.54	0.77	0.54	0.77	0.80	DDT
0.91	0.82	0.74	0.87	0.46	1.00	0.77	0.88	0.96	0.83	0.81	Stable Bleaching Powder
0.74	0.49	0.86	0.40	0.54	0.77	1.00	0.76	0.87	0.83	0.75	PVC
0.90	0.79	0.85	0.74	0.77	0.88	0.76	1.00	0.90	0.94	0.87	Phosphorus Trichloride
0.92	0.80	0.81	0.77	0.54	0.96	0.87	0.90	1.00	0.89	0.86	Chlorosulphonic Acid
0.92	0.74	0.91	0.64	0.77	0.83	0.83	0.94	0.89	1.00	0.91	Chloroacetic Acid
0.96	0.85	0.92	0.65	0.80	0.81	0.75	0.87	0.86	0.91	1.00	Carbon Tetrachloride

CHAPTER VI

END-USE PATTERN

END-USE PATTERN

Besides studying aggregate demand and supply of chlorine a study of end-use pattern of chlorine has been conducted. The end-use pattern is obtained by finding the percentage of chlorine utilized by various chlorine consuming chemicals as against its total availability over years. Such an attempt would help in predicting use pattern of chlorine and also in determination of future growth products.

These chlorine consuming chemicals can be put under three categories depending upon the percentage of chlorine utilized by them. The categories being :

(a) Heavy users : chemicals that utilize five or more than five percent of total available chlorine.

(b) Medium users : chemicals that utilize one or more than one but less than five percent of total available chlorine.

(c) Light users : chemicals that utilize less than one percent of total available chlorine.

ANALYSIS OF END-USE PATTERN

The end-use pattern of available chlorine over years i.e. 1965-1970 actual and 1979-1988 predicted, is given in Table 6.1 and 6.2.

The study reveals that liquid chlorine accounts for highest utilization and the percentage utilization of liquid chlorine is expected to increase from 26.98 percent in 1965

to 51.53 percent in 1985. For hydrochloric acid the second largest chlorine utilizing chemical the utilization percentage is expected to increase about threefold i.e. from 5.30 percent in 1965 to 20.34 percent in 1985. Also the percentage utilization for poly venyl chloride and benzene hexachloride is expected to increase from 4.82 percent and 3.54 percent in 1965 to 10.68 percent and 8.93 percent in 1985 respectively. All these four chemicals with more than 5 percent of available chlorine utilization have been classified as heavy users and growth products for future as well.

In the medium users group i.e. items utilizing chlorine between 1-5 percent of the total chlorine available are included stable bleaching powder and D.D.T. Stable bleaching powder with an initial start of 1.55 percent in 1965 attained its highest level at 2.66 percent in 1974. By the year 1988 percentage chlorine utilization for stable bleaching powder is placed at 3.71 percent. The second item in this group is D.D.T. In case of D.D.T. its percentage utilization was placed highest in 1965 at 2.17 percent. But it is predicted that the percentage utilization for D.D.T. will decrease slowly and stabilize at around 1.25 percent in 1988.

In the third group are included light users i.e. items that account for less than one percent utilization of the total chlorine available. This group includes chemicals like

phosphorous trichloride, chlorosulphonic acid, monochloro acetic acid and carbon tetrachloride. The percentage utilization of these chemicals is expected to rise only marginally i.e. from 0.08 percent in 1965 to 0.67 percent in 1988 for phosphorous trichloride, from 0.34 percent in 1966 to 0.50 percent in 1988 for chlorosulphonic acid, from 0.12 percent in 1966 to 0.59 percent in 1988 for monochloro acetic acid, and from 0.18 percent in 1969 to 3.87 percent in 1988 for carbon tetrachloride respectively.

The study shows that the percentage utilization of total available chlorine will continue to increase for heavy users i.e. hydrochloric acid, liquid chlorine, P.V.C. and B.H.C. On the other hand the percentage utilization for medium and light users will increase only marginally. It is important to point out that the unaccounted block is showing a continuous downward trend i.e. from 55.56 percent in 1965 to an expected level of only 2.25 percent in 1984. This shows clearly that by the turn of the decade in spite of increase in the availability of chlorine all the chlorine available will be fully utilized.

TABLE 6.1

PERCENTAGE UTILIZATION OF CHLORINE FOR ACQUIRED DATA

S.NO.	ITEM/YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1.	Bleaching Powder	1.55	2.13	1.56	1.56	2.05	1.72	2.01	2.18	2.51	2.66	2.59	2.22	2.34	2.56
2.	Phosphorus Trichloride	0.08	0.08	0.05	0.06	0.07	0.19	0.20	0.23	0.24	0.22	0.31	0.25	0.32	0.35
3.	Liquid Chlorine	26.98	30.76	34.18	37.16	42.43	46.22	49.01	42.84	43.70	38.86	41.56	40.64	44.09	45.34
4.	Hydrochloric Acid	5.30	3.52	4.77	4.99	8.44	5.13	6.25	6.45	11.94	8.68	14.89	15.89	10.88	12.35
5.	Poly Vinyl Chloride	4.82	3.99	4.30	4.90	8.32	9.11	9.57	10.06	10.17	9.14	7.99	7.75	9.39	9.18
6.	D. D. T.	2.17	2.01	1.98	1.67	1.57	1.88	1.86	1.67	1.48	1.31	1.67	1.53	1.39	1.33
7.	Chlorosulphonic Acid	-	0.34	0.31	0.65	0.94	0.87	0.92	1.13	1.17	1.12	1.11	1.03	1.12	0.88
8.	Carbon Tetra Chloride	-	-	-	1.08	1.67	1.76	1.90	1.91	1.75	1.77	1.97	1.27	1.31	1.99
9.	Monochloro Acetic Acid	-	0.12	0.10	0.15	0.15	0.25	0.29	0.30	0.29	0.28	0.29	0.31	0.27	0.36
10.	Benzene Hexachloride	3.54	3.67	3.29	6.07	5.25	4.66	4.48	4.63	5.43	5.38	5.61	4.86	5.38	6.28
	TOTAL CHLORINE UTILIZED	44.44	46.62	50.44	58.29	70.89	71.79	76.49	71.40	78.63	69.42	77.99	76.75	76.22	80.62
	UNACCOUNTED CHLORINE	55.56	53.38	49.56	41.71	29.11	28.21	23.51	28.60	21.32	30.58	22.01	23.25	23.78	19.38

TABLE 6.2

PERCENTAGE UTILIZATION OF CHLORINE FOR PREDICTED DATA

S.NO.	ITEM/YEAR	1979	1980	1981	1982	1983	1984	1985
1.	Bleaching Powder	2.65	2.75	2.86	2.97	3.08	3.19	3.32
2.	Phosphorus Trichloride	0.39	0.42	0.46	0.51	0.56	0.61	0.67
3.	Liquid Chlorine	46.18	47.03	47.90	48.78	49.68	50.60	51.53
4.	Hydrochloric Acid	13.26	14.24	15.29	16.42	17.64	18.94	20.34
5.	Poly Vinyl Chloride	9.38	9.58	9.80	10.01	10.23	10.45	10.68
6.	D. D. T.	1.29	1.26	1.23	1.20	1.17	1.14	1.11
7.	Chlorosulphonic Acid	0.87	0.88	0.88	0.88	0.89	0.89	0.89
8.	Carbon Tetra Chloride	2.13	2.28	2.43	2.60	2.78	2.97	3.17
9.	Monochloro Acetic Acid	0.37	0.39	0.41	0.44	0.46	0.48	0.51
10.	Benzene Hexachloride	6.60	6.94	7.30	7.68	8.07	8.49	8.93
TOTAL CHLORINE UTILIZED		83.12	85.77	88.86	91.49	95.10	97.75	101.15
UNACCOUNTED CHLORINE		16.88	14.23	11.44	8.51	4.90	2.25	-

CHAPTER VII

DEMAND, SUPPLY AND DISTRIBUTION LOGISTICS

DEMAND, SUPPLY AND DISTRIBUTION LOGISTICS

The importance of right price and quality and assured supply in industrial marketing has already been mentioned. Besides aggregate demand and supply position of chlorine, the exact physical location of the undertakings engaged in the production and consumption of chlorine will certainly prove useful in the understanding of the problem dealt with in this work. For this purpose the locations of aforesaid undertakings and statewise deficit and surplus has been found out. This information appears in Table 7.3 . A logistics model for transportation of chlorine has been developed based on its demand and supply position.

The model consists of m depots (surplus centres), the location in coordinates of depot i (where i = 1, 2, ...,m) being given as (X_i, Y_i). The depots supply n customers (consumption centres), the coordinates of customer j (where j = 1, 2, ...n) being (X_j, Y_j) . If the cost of transportation of the chlorine supplied to customer j from depot i is denoted by C_{ij} then the total distribution cost is :

$$H = \sum_{i=1}^{m} \sum_{j=1}^{n} C_{ij}$$

When the transportation cost depends linearly on the weight of chlorine delivered and the distance travelled, then :

$$C_{ij} = \alpha_{ij} \; W_{ij} \; d_{ij}$$

where α_{ij} = cost per unit weight and distance;

W_{ij} = weight transported from depot i to customer j;

d_{ij} = the distance from i to j; if straight line distances are considered.

For a given set of customers and depots, the cost matrix (α_{ij}) and the distance matrix (d_{ij}) are known, the problem can be formulated as a standard transportation model with the object of determining W_{ij} to minimize the total cost function. The computer programme for this purpose was run on IBM-1130 and the results regarding this aspect appear in the next chapter. The listing of the programme is attached in Appendix V.

Because of nonavailability of actual production data of individual undertakings, this part of the study has been conducted based on the installed capacity data (capacity limit to which the unit can produce with existing infrastructural facilities) and not with licenced or actual production data. So a very optimal case is considered for this analysis.

ANALYSIS OF OPTIMUM DISTRIBUTION OF CHLORINE

The analysis of individual as well as states for determination of deficit and surplus units is shown in this section. It is found that the individual units can be divided into three categories based on production and/or

consumption of chlorine by them. The categories being :

(a) Units that produce as well as consume chlorine but whose consumption of chlorine exceeds their production i.e. they are deficit of chlorine.

(b) Units that produce as well consume chlorine but whose consumption is less than their production i.e. they have surplus of chlorine.

(c) Units that only consume chlorine.

In all fortynine units were considered for this study which either produce or consume chlorine or do both. On categorising these units on the above mentioned basis, it is found that :

Category (a) has 12 units.

Category (b) has 21 units.

Category (c) has 16 units.

So out of the 49 units considered, there are 21 units in the country that have surplus of chlorine and 28 units that are deficit in chlorine. Both deficit as well as surplus units are situated in nineteen different places in the country. All these units are scattered throughout the fourteen different states and one union territory; except for northern-eastern region where no unit dealing with these chemicals is situated. The maximum number of these units i.e. 15 is in Maharashtra state. Out of these fourteen states and one union territory, five states and one union

territory are deficit of chlorine while nine states have surplus of chlorine.

State with maximum deficit of chlorine is Maharashtra and the deficit is 29,286 tons while the state with maximum surplus of chlorine is Madhya Pradesh, surplus being 38,970 tons. The net surplus of chlorine in the country is 20,398 tons.

Unit that produces the maximum amount of chlorine i.e. 63,999 tons is D.C.M. Chemical Works Delhi, while the unit that has the maximum amount of surplus of chlorine i.e. 36,300 tons is Gwalior Rayons, Nagda. This unit is mainly responsible for making Madhya Pradesh as the state with largest chlorine surplus. Kanoria Chemical & Industries Ltd. has the maximum deficit of chlorine and deficit being equal to 24,349 tons.

Table 7.1 shows straight line land routes distances between surplus and deficit centres. The optimal solution of the transportation problem is shown in Table 7.2. The sources that supply chlorine to the dummy destination i.e. surplus chlorine not being utilized are :

(i) Shriram Chemical Industries, Kota, Rajasthan

(ii) Travancore Cochin Chemical Ltd., Udyogmandal, Kerala

(iii) Saurashtra Chemicals, Porbandar, Gujrat

(iv) Tata Chemicals, Mithapur, Gujrat.

	1	2	3	4	5	6
A	1,000	860	300	800	1,030	1,250
B	430	200	690	200	850	1,140
C	970	810	90	700	670	900
D	1,470	1,330	940	1,230	220	130
E	1,260	1,150	700	1,190	1,440	1,640
F	150	240	1,000	310	1,200	1,520
G	150	120	920	180	1,100	1,400
H	1,260	1,100	250	1,000	820	980
I	1,600	1,420	600	1,320	1,130	1,200
J	1,630	1,450	620	1,370	1,110	1,250
K	1,350	1,320	1,420	1,360	2,050	2,300
L	650	580	900	510	700	1,010
M	1,420	1,370	1,330	1,390	2,050	2,300
N	1,380	1,200	420	1,100	570	670
O	1,210	1,060	420	980	1,150	1,340
P	450	520	1,290	580	1,270	1,590
Q	550	550	1,100	550	1,000	1,280
R	360	360	1,210	500	1,250	1,550
S	850	700	280	600	970	1,210

ALL DISTANCES IN KILOMETERS

TABLE 7.1

DISTANCES BETWEEN SURPLUS AND DEFICIT CENTRES

7	8	9	10	11	12	13	14
1,000	500	290	400	350	1,000	910	1,030
280	760	920	920	920	1,350	1,100	1,[illegible]70
750	740	340	320	320	1,330	1,200	1,380
900	1,590	1,100	970	1,030	2,200	2,010	2,250
1,390	560	570	700	610	790	800	750
520	880	1,290	1,300	1,300	1,370	1,100	1,530
430	490	1,150	1,160	1,150	1,300	1,050	1,460
1,050	900	130	0	80	1,400	1,300	1,400
1,430	1,200	400	380	380	1,650	1,600	1,650
1,450	1,220	430	390	400	1,710	1,610	1,690
1,800	760	1,360	1,500	1,420	150	410	130
70	1,100	1,150	1,100	1,110	1,700	1,470	1,820
1,800	750	1,270	1,390	1,310	260	500	60
1,000	1,150	460	330	400	1,700	1,600	1,710
1,200	640	250	390	320	1,050	1,000	1,020
580	1,160	1,520	1,520	1,510	1,640	1,400	1,800
300	1,180	1,360	1,340	1,350	1,710	1,460	1,710
530	1,090	1,460	1,470	1,450	1,550	1,300	1,720
830	460	430	470	430	1,050	900	1,100

SURPLUS CENTRES	1	2	3	4	5	6	7
A	0	0	0	0	0	0	0
B	0	0	0	1040	0	0	2920
C	0	0	210	0	0	0	12620
D	0	0	0	0	5580	60	0
E	0	0	0	0	0	0	0
F	5380	0	0	0	0	0	0
G	0	0	0	40	0	0	0
H	0	0	0	0	0	0	0
I	0	0	0	0	0	0	0
J	0	0	0	0	0	0	0
K	0	0	0	0	0	0	0
L	0	0	0	0	0	0	4540
M	0	0	0	0	0	0	0
N	0	0	0	0	2720	0	0
O	0	0	0	0	0	0	0
P	0	0	0	0	0	0	0
Q	0	0	0	0	0	0	320
R	1090	30	0	0	0	0	3950
S	0	0	0	0	0	0	0

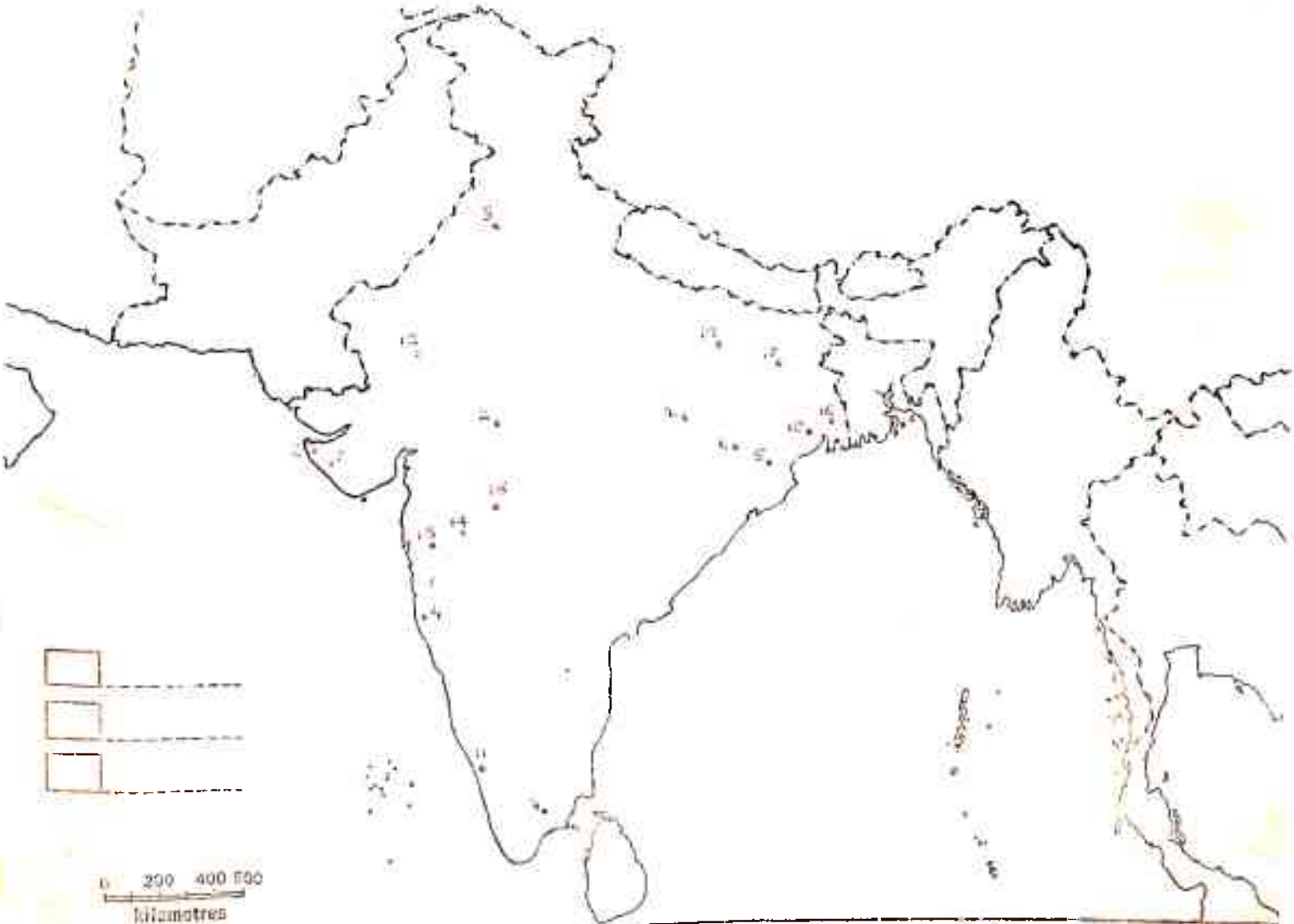
ALL FIGURES IN TONS

TABLE 7.2

TRANSPORTATION PROBLEM OPTIMAL SOLUTION

DEFICIT CENTRES

8	9	10	11	12	13	14
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	330	0	0	0	0
0	7850	0	4570	0	0	0
0	0	0	0	0	0	0
0	0	0	0	17600	0	0
0	0	0	0	0	0	0
0	0	0	0	210	2700	2700
0	0	810	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
1500	0	0	0	0	0	0



The territorial waters of India extend into the sea to a distance of twelve nautical miles measured from the appropriate base-line. 1981
The External Boundary and coast-line of India shown on this map agree with the Record/Master copy certified by the Survey of India, Dehra Dun, vide their letter No. T. 8.606/82 -A-3/213 dated 28-2-81.

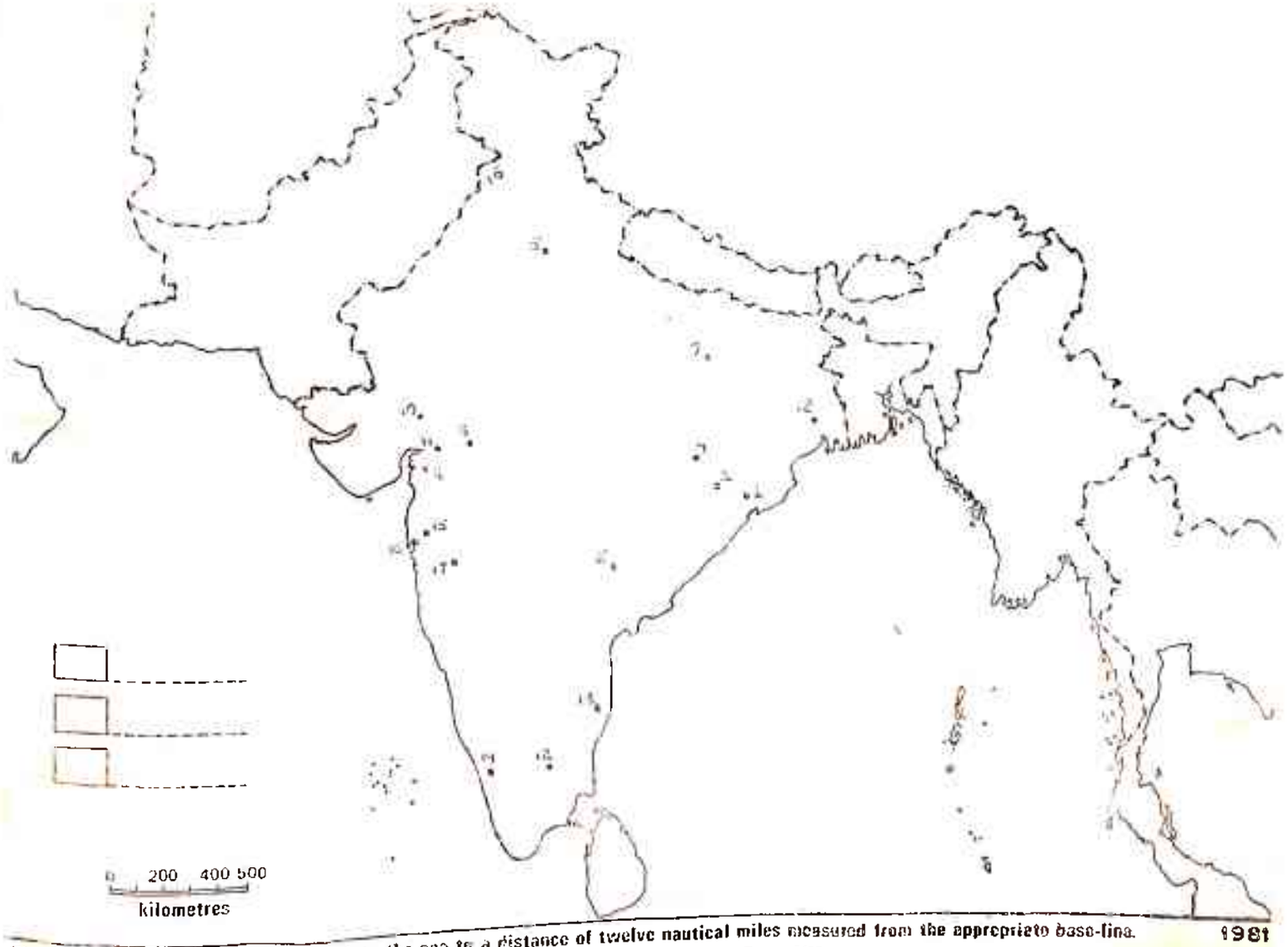
CHLORINE SURPLUS CENTRES

1. Amlai, M. P.
2. Nagda, M. P.
3. Yamunanagar, Haryana
4. Karwar, Karnataka
5. Tanuku, A. P.
6. Kaghaznagar, A. P.
7. Porbandar, Gujrat
8. Mithapur, Gujrat
9. Sahapuram, T. N.
10. Dalmianagar, Bihar
11. Udyogmandal, Kerala
12. Kota, Rajasthan
13. Kalyan, Maharashtra
14. Daulatabad, Maharashtra
15. Ballarpur, Maharashtra
16. Khardah, W. B.
17. Durgapur, W. B.
18. Titagarh, W. B.

SURPLUS CENTRES

A.	Titagarh Paper Mills, Daulatabad, Maharashtra	= 1,452
B.	Hukumchand Jute Mills, Amlai, M.P.	= 3,960
C.	Gwalior Rayons Silk Mfg.(Wvg.) Co., Nagda,M.P.	= 36,300
D.	Ballarpur Paper Mills, Yamunagarh, Haryana	= 5,641
E.	Ballarpur Paper Mills, Karwar, Karnataka	= 2,091
F.	Andhra Sugars Ltd., Tanuku, A.P.	= 5,380
G.	Sirpur Paper Mills, Kaghaznagar, A.P.	= 37
H.	Ahmedabad Mfg. & Calico Printing Co., Ahmedabad, Gujrat	= 331
I.	Saurashtra Chemicals, Porbandar, Gujrat	= 17,952
J.	Tata Chemicals Ltd., Mithapur, Gujrat	= 981
K.	Dhrangadhra Chemicals, Sahupuram, T.N.	= 17,600
L.	Rohtas Ind. Ltd., Dalmianagar, Bihar	= 4,536
M.	Travancore Cochin Chem. Ltd., Udyogmandal, Kerala	= 10,326
N.	Shriram Chemicals Industries, Kota, Rajasthan	= 16,470
O.	Century Chemicals, Kalyan, Maharashtra	= 16,479
P.	National Rayon Corpn. Ltd., Kalyan, Maharashtra	
Q.	Industan Heavy Chem. Ltd., Khardah, W.B.	= 3,221
R.	Titagarh Paper Mills, Titagarh, W.B.	= 5,892
S.	Durgapur Chem. Ltd., Durgapur, W.B.	= 324
T.	Ballarpur Paper Mills, Ballarpur, Maharashtra	= 4,340
U.	Shree Gopal Unit, Ballarpur, Maharashtra	

ALL FIGURES IN TONS



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CHLORINE DEFICIT CENTRES

1. Ganjam, Orissa
2. Brajrajnagar, Orissa
3. Nepanagar, M. P.
4. Kumhari, M. P.
5. Delhi
6. Amritsar, Punjab
7. Mirzapur, U. P.
8. Hyderabad, A. P.
9. Atul, Gujrat
10. Ahmedabad, Gujrat
11. Baroda, Gujrat
12. Metturdem, T. N.
13. Madras, T. N.
14. Alwaye, Kerala
15. Thana, Maharashtra
16. Bombay, Maharashtra
17. Rasayani, Maharashtra
19. Rishra, W. B.

DEFICIT CENTRES

1.	Jayashree Chemicals Ltd., Ganjam, Orissa	= 6,474
2.	Orient Paper Mills Ltd., Brajrajnagar, Orissa	= 30
3.	National Newsprint & Paper Mills, Nepanagar	= 210
4.	Dharmsi Morarji Chem. Co., Kumhari, M.P.	= 1,080
5.	D.C.M. Chemicals Works, Delhi Hindustan Insecticides, Delhi	= 8,303
6.	Shambhu Nath & Sons, Amritsar	= 58
7.	Manoria Chemicals & Ind. Ltd., Mirzapur, U.P.	= 24,349
8.	Hyderabad Chem. & Text, Hyderabad, A.P.	= 1,500
9.	Atul Products Ltd., Atul, Gujrat Sardesai Brothers, Atul, Bulsar, Gujrat	= 7,854
10.	Cellulose Products of India Ltd., Ahmedabad	= 1,140
11.	Gujrat Alkali & Chem.,Ltd., Baroda, Gujrat	= 4,566
12.	Mettur Chemical & Ind. Corp. Ltd., Metturdam Chemical & Plastics India, Metturdam, T.N.	= 17,807
13.	Mico Farm Chemical Ltd., Madras, T.N.	= 2,700
14.	Hindustan Insecticides Ltd., Alwaye, Kerala	= 2,700
15.	J. K. Chemicals Ltd., Kalyan, Maharashtra	= 1,326
16.	Standard Mills Co. Ltd., Thana, Maharashtra National Organic Chemicals, Thana Dharmsi Morarji Chemicals, Thana Deverest Refrigerents Ltd., Thana	= 27,401
17.	Ahmedabad Manufacturing & Calco Printing Co. Pesticides & Brwers Ltd., Bombay Indian Organic Chem., Bombay Excel Industries Ltd., Bombay	= 18,679
18.	Hindustan Organic Chem. Ltd., Rasayani, Maharashtra	= 2,700
19.	Alkali & Chem. Corpn. of India Ltd., Rishra, W. B.	= 4,039

ALL FIGURES IN TONS

S.NO.	NAME	LOCATION
B.3.	Ahmedabad Mfg. & Calico Printing Co. Ltd.	Ahmedabad
B.4.	Saurashtra Chemicals	Porbandar
B.5.	Tata Chemicals Ltd.	Mithapur
C.6.	Cellulose Products of India Ltd.	Ahmedabad
C.7.	Sardesai Brothers	Bulsar
	MADHYA PRADESH	
A.1.	National Newsprint & Paper Mills Co.	Nepanagar
B.2.	Hukamchand Jute Mills Ltd.	Amlai
B.3.	Gwalior Rayon Silk Mfg. (Wvg.) Co. Ltd.	Nagda
C.4.	Dharamsi Morarji Chem. Co.	Kumhari
	ORISSA	
A.1.	Jayshree Chemicals Ltd.	Ganjam
A.2.	Orient Paper Mills Ltd.	Brajrajnagar

ITEM	LICENSED CAPACITY	INSTALLED CAPACITY	ACTUAL PRODUCTION
C. Soda	2,333	2,333	-
Liq. Chlorine	1,541	1,541	-
HCl	604	604	-
C. Soda	20,400	20,400	-
C. Soda	13,700	13,700	6,463
Liq. Chlorine	9,700	9,700	5,451
HCl	9,650	9,650	4,177
BHC	7,200	7,200	6,644
Mono Chloro A. A.	3,000	-	-
Mono Chloro A. A.	960	960	-
C. Soda	8,928	4,025	3,862
Liq. Chlorine	9,910	3,572	3,427
HCl	1,200	600	139
C. Soda	22,680	22,680	16,000
Liq. Chlorine	18,700	12,758	7,250
HCl	8,640	10,800	4,815
C. Soda	33,000	41,250	39,914
Chloro Sulph. A.	3,600	3,600	-
C. Soda	42,000	16,764	-
Liq. Chlorine	25,200	13,411	-
Bleaching P.	8,382	8,400	-
HCl	25,000	14,850	-
C. Soda	3,292	3,292	2,855
Liq. Chlorine	2,926	2,926	2,512

TABLE 7.3

DETERMINATION OF DEFICIT AND SURPLUS CENTRES

S.No.	NAME	LOCATION	ITEM	LICENSED CAPACITY	INSTALLED CAPACITY	ACTUAL PRODUCTION	Cl_2 USED/ PRODUCED	Cl_2 DEFICIT/ SURPLUS	NET Cl_2 DEFICIT/ SURPLUS IN STATE
	ANDHRA PRADESH								
B.1.	Andhra Sugars Ltd.	Tanuku	C. Soda	46,200	36,300	33,762	31,945		
			Acetic Acid	1,080	1,080	719	410		
			Liq. Chlorine	29,730	22,615	17,976	22,615		
			HCl	7,100	6,800	12,916	2,040		
			Chloro Sulph. A.	10,000	5,000	4,856	1,500	+ 5,380	
B.2.	Sirpur Paper Mills	Kaghaznagar	C. Soda	6,037	7,024	5,206	6,181		
			Liq. Chlorine	5,122	6,144	4,076	6,144	+ 37	
C.3.	Hyderabad Chem. & Fert.	Hyderabad	Chloro Sulph. A.	5,000	-	-	1,500	- 1,500	+ 3,917
	BIHAR								
B.1.	Rohtas Industries Ltd.	Dalmianagar	C. Soda	7,800	5,400	2,808	4,752		
			HCl	720	720	488	216	+ 4,536	+ 4,536
	DELHI								
A.1.	D.C.M. Chemical Works	Delhi	C. Soda	1,15,500	72,600	48,968	63,888		
			HCl	79,750	55,250	34,860	16,575		
			Bleaching P.	33,000	25,000	18,365	10,000		
			Liq. Chlorine	75,180	41,250	21,513	41,250		
			Chloro Sulph. A.	-	-	832	250	- 4,187	
C.2.	Hindustan Insecticides	Delhi	D. D. T.	2,744	2,744	-	4,116	- 4,116	- 8,303
	GUJRAT								
A.1.	Atul Products Ltd.	Atul	C. Soda	6,200	-	-	5,456		
			HCl	11,400	11,400	-	3,420		
			Phosph. Tri. Chl.	800	800	-	616		
			Chloro Sulph. A.	4,000	4,000	-	1,200		
			Mono Chlo. A. A.	750	750	-	285		
			Liq. Chlorine	7,425	7,425	-	7,425	- 7,490	
A.2.	Gujrat Alkali & Chem. Ltd.	Baroda	C. Soda	70,425	37,425	48,400	32,934		
			Liq. Chlorine	64,000	33,000	16,320	33,000		
			HCl	29,000	15,000	26,898	4,500	- 4,566	

S.NO.	NAME	LOCATION
	PUNJAB	
C.1.	Shambhu Nath & Sons	Amritsar
	RAJASTHAN	
B.1.	Shriram Chemicals	Kota
	TAMILNADU	
A.1.	Mettur Chemical & Ind. Corpn. Ltd.	Mettur Dam
B.2.	Dhrangadhra Chem. Works Ltd.	Sahupuram
C.3.	Mico Farm Chemicals Ltd.	Madras
C.4.	Chemical & Plastics India	Mettur Dam
	UTTAR PRADESH	
A.1.	Kanoria Chem. & Industries Ltd.	Mirzapur
	WEST BENGAL	
A.1.	Alkali & Chemical Corpn. of India Ltd.	Rishra

ITEM	LICENSED CAPACITY	INSTALLED CAPACITY	ACTUAL PRODUCTION
HCl	194	-	-
C. Soda	33,300	-	-
HCl	2,400	-	-
PVC	15,800	15,800	-
C. Soda	46,600	46,600	47,650
Bleaching P.	17,460	17,460	6,820
HCl	18,810	18,810	-
Liq. Chlorine	30,000	30,000	-
Carbon Tet. Chl.	1,080	1,080	-
C. Soda	60,000	50,000	-
HCl	39,600	33,000	-
Liq. Chlorine	16,500	16,500	-
BHC	3,000	-	-
PVC	20,000	-	-
C. Soda	33,000	33,000	20,057
Liq. Chlorine	21,780	21,780	21,790
HCl	49,365	49,365	13,434
Bleaching P.	15,000	15,000	6,045
BHC	12,000	12,000	12,329
C. Soda	7,041	8,801	8,260
BHC	5,200	5,200	1,889
HCl	4,300	4,300	1,748
Liq. Chlorine	5,814	5,814	5,814

S.NO.	NAME	LOCATION	ITEM
B.2.	Hindustan Heavy Chem. Ltd.	Khardah	C. Soda HCl Liq. Chlorine
B.3.	Durgapur Chem. Ltd.	Durgapur	C. Soda Liq. Chlorine
B.4.	Titagarh Paper Mills Ltd.	Titagarh	C. Soda
	HARYANA		
B.1.	Ballarpur Paper Mills	Yamunanagar	C. Soda Liq. Chlorine HCl
	KERALA		
B.1.	Travancore Cochin Chem. Ltd.	Udyogmandal	C. Soda HCl Liq. Chlorine
C.2.	Hindustan Insecticides	Alwaye	BHC
	KARNATAKA		
B.1.	Ballarpur Paper Mills	Karwar	C. Soda Liq. Chlorine HCl
	MAHARASHTRA		
A.1.	J.K. Chemicals Ltd.	Kalyan	C. Soda HCl Liq. Chlorine
A.2.	Standard Mills Co. Ltd.	Thana	C. Soda HCl Carbon Tet. Chl. Liq. Chlorine

LICENSED CAPACITY	INSTALLED CAPACITY	ACTUAL PRODUCTION	Cl_2 USED/ PRODUCED	Cl_2 DEFICIT/ SURPLUS	NET Cl_2 DEFICIT/ SURPLUS IN STATE
6, 706	-	-	5,901		
2,010	1,100	-	330		
5,690	2,350	-	2,350	+ 3,221	
10,500	-	-	9,240		
8,916	-	-	8,916	324	
6,696	6,696	-	5,892	+ 5,892	+ 5,398
62,700	62,700	-	55,176		
48,500	48,500	-	48,500		
3,450	3,450	-	1,035	+ 5,641	+ 5,641
66,000	35,530	-	31,266		
25,800	25,800	-	7,740		
13,200	13,200	-	13,200	+10,326	
3,000	-	-	2,700	- 2,700	+ 7,626
16,500	-	16,976	14,895		
-	-	9,037	9,037		
-	-	12,558	3,767	+ 2,091	+ 2,091
1,016	1,016	-	894		
1,500	1,500	-	450		
1,770	1,770	-	1,770	- 1,236	
51,990	51,990	-	45,751		
15,560	15,560	-	4,668		
2,100	-	-	2,310		
45,036	45,036	-	45,036	- 6,236	

S.NO.	NAME	LOCATION	ITEM
A.3.	Ahmedabad Mfg. & Calico Printing Co.	Bombay	C. Soda HCl Liq. Chlorine PVC
B.4.	Century Chemicals	Kalyan	C. Soda
B.5.	National Rayon Co. Ltd.	Kalyan	C. Soda Liq. Chlorine HCl Carbon Tet. Chl.
B.6.	Ballarpur Paper Mills	Ballarpur	C. Soda HCl Liq. Chlorine
B.7.	Shree Gopal Unit	Ballarpur	C. Soda HCl Liq. Chlorine
C.8.	National Organic Chemicals	Thana	PVC
C.9.	Hindustan Organic Chemical Ltd.	Rasayani	BHC
C.10.	Pesticides & Brewers Ltd.	Bombay	BHC
C.11.	Indian Organic Chem.	Kolaba	Mono Chl. A. A.
C.12.	Dharamsi Morarji Chem.	Thana	Chloro Sulph. A.
C.13.	Excel Industries Ltd.	Bombay	Phospho. Tri. Chl.
C.14.	Everest Refrigerants Ltd.	Thana	Carbon Tet. Chl.
C.15.	Titagarh Paper Mills	Daulatabad	C. Soda

ALL FIGURES IN TONS

LICENSED CAPACITY	INSTALLED CAPACITY	ACTUAL PRODUCTION	Cl_2 USED/ PRODUCED	Cl_2 DEFICIT/ SURPLUS	NET Cl_2 DEFICIT/ SURPLUS IN STATE
28,950	28,950	-	25,476		
6,126	6,126	-	1,837		
24,752	-	-	24,752		
20,000	20,000	-	15,000	-16,113	
9,900	9,900	14,668	8,712	+ 8,712	
26,400	31,000	19,925	27,280		
15,140	15,140	10,796	15,140		
10,800	10,800	17,604	3,240		
1,680	1,030	1,269	1,133	+ 7,767	
-	-	4,025	3,542		
-	-	1,145	343		
-	-	830	830	+ 2,369	
-	-	4,789	4,214		
-	-	1,936	580		
-	-	1,663	1,663	+ 1,971	
20,000	20,000	-	15,000	-15,000	
3,000	-	-	2,700	- 2,700	
2,275	-	-	2,047	- 2,047	
1,000	-	-	380	- 380	
13,200	13,200	-	3,960	- 3,960	
180	180	-	138	- 138	
1,980	1,980	-	2,178	- 2,178	
1,650	-	-	1,452	+ 1,452	-27,834

PACKAGING, DISTRIBUTION AND TRANSPORTATION OF CHLORINE

Chlorine in industry and commerce is classified as a non-flamable compressed gas. It is a liquified gas under pressure. The chlorine in containers has both a liquid and a gas phase. Hazards associated with chlorine handling are attributable to its chemical reactivity, physical properties and toxicological character. Though neither liquid nor gaseous chlorine is explosive or flamable, both react chemically with many inorganic and organic substances; usually with the evolution of heat. Chlorine also supports combustion. At ordinary temperature, dry chlorine, does not react with many metals but it is very reactive in the presence of moisture. One volume of liquid chlorine vaporises into about 450 volumes of gas, a significant fact that should be reckoned with in handling of chlorine.

Liquid chlorine is a skin irritant and can cause damage to skin tissues. It vaporises rapidly to gas at normal atmospheric pressure and temperature conditions. In low concentration chlorine gas, irritates the mucous membranes, the respiratory system and the skin. In extreme cases the difficulty of breathing may increase to the point where death can result from suffocation.

All these factors require careful and safe handling of chlorine, specially with respect to its packaging and transportation.

TABLE 7.4

PHYSIOLOGICAL RESPONSE TO VARIOUS CONCENTRATIONS OF CHLORINE GAS

Effect	Parts chlorine gas per million parts Avi. by volume (ppm)
(a) Least amount required to produce slight symtoms after several hours exposure	1
(b) Least detectable odor	3.5
(c) Maximum amount that can be inhaled for one hour without serious disturbances	4
(d) Noxiousness, impossible to breathe several minutes	5
(e) Least amount required to cause irritation of throat	15.1
(f) Least amount required to cause coughing	30.2
(g) Amount dangerous in 30 minutes to one hour	40 to 60
(h) Kills most animals in very short time	1000

Source : Department of Scientific and Industrial Research, "Methods for the Detection of Toxic Gases in Industry - Chlorine", London, 1955.

Almost all the plants in India producing caustic-soda make captive use of chlorine for the manufacture of products like Hydrochloric acid, P.V.C., D.D.T., Bleaching powder, etc. A good amount of chlorine is also utilized

directly for bleaching purposes. Only about 40 percent of the total chlorine produced requires packaging and transportation from producing centres to consumption centres. In India chlorine is packed in cylinders and tin containers that must comply with Indian Standard Institutions' standards. The mode of transportation of these chlorine containers is basically road transportation mainly through trucks. Tin containers and multi-unit tank cars can also be used for chlorine transportation, but these are not much in use in India. Chlorine should be handled according to the Indian Standard Institution's specification so that no untoward incident occurs.

SPECIFICATION OF CHLORINE GAS CYLINDERS (WELDED TYPE)

(A) SPECIFICATIONS

(i)	Volumetric water capacity	.. 64 Ltrs.
(ii)	Filling ratio	.. 1.19
(iii)	Gas capacity	.. 100 Kgs
(iv)	Filling pressure at 65°C	.. 19.90 kg/cm^2 (max)
(v)	Test pressure (hydraulic)	.. 29.85 kg/cm^2 (min.)
(vi)	Leakage test pressure	.. 20 kg/cm^2 (min.)
(vii)	Tare weight	.. 65 kgs. (approx.)
(viii)	Material	.. IS:6240 Grade-B

(B) VALVE .. IS:3224:1971

Valve as per

(C) DESIGN

(i) Nominal diameter of cylinder	..	368 mm
(ii) Nominal wall thickness	..	6 mm
(iii) Length excluding valve & cap	..	998 mm (Approx.)
(iv) Number of weld joints	..	3
(v) Manufactured according to	..	IS:7681:1975

Moving

Loaded cylinders may be moved on properly balanced trucks. If they are to be lifted and an elevator is not available, a crane or hoist having a special cradle or carrier should be used. Cylinders should not be lifted by means of the valve protection hood. Unloading docks preferably should be at truck-bed level.

Cylinders containing chlorine being trucked should be carefully checked, clamped, or otherwise suitably supported to prevent shifting and rolling. They should not be permitted to drop, and no object should be allowed to strike them with force.

Storage

Cylinders, whether empty or full, should be stored in a dry, well-ventilated area, protected from external heat sources. Fire-resistant storage areas are recommended and sub-surface areas are to be avoided. Cylinders should be stored in an up-right position. Storage should be arranged so as to facilitate moving.

CHAPTER VIII

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS AND RECOMMENDATIONS

In India the basic aim in the initial stages was the production of caustic-soda normally at the expense of chlorine which was considered as a waste product. It was mainly disposed of through destruction by lime or sale. In optimising operations of caustic-soda units, the most important factor is to achieve a very high level of captive chlorine utilization i.e. beyond 90 per cent. Chlorine in atmosphere is the main factor for all the ills of chlor-alkali industry directly or indirectly.

Studies carried out and described in the previous chapters suggest that the demand for chlorine as well as caustic-soda will continue to increase with an increasing pace of industrial development in the country. This fact is also supported by the forecast that the production of chlorine utilizing chemicals like P. V. C. and B. H. C. is going to increase tremendously on account of the large demand from all quarters of the industry for them. P. V. C. being the cheapest thermoplastic material and not being soluble in most of the organic solvents has already found uses as diverse as shower-curtains and heavy structural pipes. With the development of pulp and paper industry in the country, liquid chlorine will find more outlets for its effective utilization. Greater utilization of its capacity is important and essential from economic point of view.

The demand for caustic-soda and chlorine both will be well met indigenously in future. The following projects are under different stages of finalisation.

Name of the undertaking	Caustic-soda Production TPD
GACL - Expansion already under implementation	100
PSIDC	100
Hindustan Paper Corpn.	110
Bihar Caustic & Chemicals	100
Modi Spinning & Wvg. Mills	100
Bharat Aluminium Co. Ltd.	250
Shriram Chemical Industries Expansion	150
Kothari (Madras) Ltd. Expansion	100
TCC Expansion	70
Total additional capacity	1,080

Chlor-alkali industry is a power intensive industry. In addition to the cost of power which has become the single highest element of the cost of production of caustic-soda, costs of other inputs have also gone up by about five to six times while the price of caustic-soda has increased only by four to five times[1]. In the light of these facts it becomes

1. Srivastava S. P., "OPTIMIZATION OF CAUSTIC-SODA/CHLORINE PLANT OPERATIONS WITH SPECIAL REFERENCE TO ENERGY SAVING" GACL, Udhe India Ltd., Engineering Division, Bombay, 1980, p. 47.

necessary that the optimisation process should not only emphasise the minimisation of power consumption but also the maximisation of chlorine utilization. Any step in this direction will lead to justify a responsible role by chlor-alkali industry in the industrial development of the nation.

Though the industry is not likely to face any difficulty in marketing its products in future, the geographical distribution of chlorine demand has some interesting features. Thus, the strategic decision on the location of caustic-soda plant has to be made based on critical evaluation of economics and problems concerning transportation of chlorine and caustic-soda. Since transportation of large quantities of chlorine is expensive and risky, integration of chlorine plants with the major chlorine consuming centres and the transport of caustic-soda as lye or solid appears to be the realistic solution.

An important observation that needs mention is that the increase in demand for chlorine will lead to a situation beyond 1985 when demand for chlorine is likely to exceed its availability. Such a situation would require manufacture of chlorine in excess of what would be available as a result of caustic-soda production. The additional requirements for chlorine could be met by either of the following methods :

(a) Production of chlorine through increased production of caustic-soda.

(b) Production of chlorine by means other than caustic-soda production.

As we have already seen that from economic as well as industrial point of view, it is the former method that is preferred.

Thus, we can conclude that after another five years the chlor-alkali industry would enter the situation which is just reverse of what is existing today. Therefore, it is time that the chlor-alkali industry should bring about a shift in their orientation and efforts. Rather than finding out means for controlling pollution and chlorine disposal, as at present, attention should be directed to further develop and discover means to enhance demand for caustic-soda. Such an attempt is imperative for the success and growth of the industry.

APPENDICES

APPENDIX I

EARLY HISTORY OF CHLORINE

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EARLY HISTORY OF CHLORINE

The history of elemental chlorine is relatively short, embracing less than two hundred years, yet the story of chlorine compounds reaches far back into prehistoric times. To find the proper perspective for evaluating the role of chlorine in modern society it is important to examine briefly the part of basic raw material for chlorine, Salt i.e. Sodium Chloride.

Long before any other mineral resources of the earth had been utilized for human endeavours, salt was a determining factor in the organisation of primitive society. Thousands of years ago, the Chinese, the Egyptian, and the Hindu scholars tried to establish the time and place of the discovery of salt, but because it had been in use long before man learned to report events, their efforts were unsuccessful. It is, therefore, reasonable to assume that the first organised search for and exploitation of natural salt resources coincides with the first tentative formation of agricultural societies, presumably by Manolithic people before 6000 B. C.

Since all body fluids contain chloride compounds, 25% in human blood, 0.1% - 0.2% as hydrochloric acid in the gastric juices, the maintenance of the proper chloride

level is essential for life. So long as the human race was restricted to a nomadic existance where man primarily lived on milk and flesh which contain adequate amount of sodium chloride, the addition of salt to diet was not necessary. On the other hand, a cereal or vegetable diet calls for a suppliment of salt. Thus, the habitual use of salt, the most common chlorine compound became intimately related to the advance from nomadic to agricultural life. An adequate supply of salt was a prerequisite for the transformation from the demanding life of the hunter. Readily accessible sources of salt were an essential factor in setting a stage for the rise of civilization in historical times. It is undoubtedly no coincidence that the cradle of many civilizations is found in coastal regions where recovery of sea salt could be achieved conveniently. Thus, it is surprising, that in the face of the important role common salt came to assume in early society, scientific investigation of this commodity was taken up so late.

The first written records of rock salt are ascribed to Herodot (5th Century B. C.) who has mentioned about the rock salt deposits in Lebia. Since that area was generally known as Ammonia, the early scholars named the mineral as salt ammonia. The purification of rock salt was first successfully attempted by Geber (8th Century). The process of dissolution, filteration and evaporation of the filtered liquid was well known to them.

Rock salt had already been put to technical use by the Romans, especially in one of the most important technological problem of the times - the separation of silver from gold. Pliny' (77 A.D.) described their manner of purification of gold by heating it with salt (iron or copper sulphate) and sonistos (clay). This mixture gave off fumes of Hydrogen chloride; however the actual mechanism of this purification and the nature of the effluvia was not recognized or further investigated at that time.

The preparation of dilute aqueous hydrochloric acid by the distillation of common salt with vitirol (the common name for all water soluble sulphates of bivalent heavy metals, in particular iron, copper, manganese and zinc) was first mentioned by Basilius Valentinus. Libarius gives several prescriptions and includes alum as a possible ingredient of the starting mixture. Although these are the first records of the preparation of 'hydrochloric acid', it is more than likely that it was made repeatedly by earlier investigators. As a point of interest it might be mentioned that with the overemphasis not infrequently accorded to new inventions, hydrochloric acid was actually recommended as a substitute for vinegar and lemon juice, for salting roasted meat, for preserving fruit and as a basic ingredient for a soft drink prepared from the acid with honey and sugar.

Glanber emphasized the necessity for the presence of water in his preparation of hydrochloric acid. Boyle observed the evaluation of the gas upon contacting alkali salts of this aqueous acid with strong sulphuric acid. Hales noticed the formation of a readily water soluble gas on heating ammonium chloride with oil of vitriol. It was left to Priestley, however, to collect hydrogen chloride gas over mercury and to describe its properties; he called it marine acid air.

There can be little doubt that the corrosive, suffo- cating greenish-yellow fumes of chlorine actually have been observed ever since the thirteenth century when the know- ledge of Aquaregia became wide spread among alchemists. It is C. W. Sheele's merit, however, to have started a closer examination of this gas. He described it in much detail in his treatise on pyroluste. On digesting pyroluste (manga- nese dioxide) with hydrochloric acid, he noticed an odour re- miniscent of aquaregia. In investigating the source of this odour, he collected the evolved gas and tested it with seve- ral agents. He noticed the yellow-greenish colour of chlo- rine and discoverd its bleaching effect on vegetable matter, the reaction with mercuric sulphide to give mercuric chlo- ride, its suffocating effect upon insects and its attack upon as noble a metal as gold. C.W. Scheile considered this gas to be muriatic acid freed of its combustible property (phlogiston). Accordingly in the language of his time, he

called it dephlogisticated marine acid air. B. Pelletier (1785) and W. J. G. Karsten (1786) observed the formation of yellow crystals on cooling moist chlorine. Until 1810 these crystals were not formed by pure, dry chlorine and demonstrated the presence of water in chlorine hydrate. Faraday determined the quantitative composition in 1823; following a suggestion by Dray he examined the termal decomposition in sealed vessels and thus obtained liquid chlorine. The incandescence displayed by several metals and metal sulphides in contact with chlorine was discovered by Westrunb in 1799.

It was not until the representatives of the chloristic school had made it clear that exceptional status was claimed for chlorine, until iodine had been discovered and its properties described, until the cyanols were analyzed and shown to contain no oxygen (Gay-bassac 1815) that chlorine was unambiguously granted the rank of a chemical element.

THE EARLY HISTORY OF CHLORINE

6000 B.C.	Establishment of agricultural societies.
3000 B.C.	Archaeological evidence for the use of rock salt.
400 B.C.	Written records on salt.
100 A.D.	'Industrial' use of salt in purification of noble metals.
800	Purification of rock salt.
1300	Presumably first observations of chlorine gas.
1600	Preparation of dilute hydrochloric acid.
1650	Preparation of concentrated hydrochloric acid.
1772	Preparation of gaseous hydrogen chloride.
1773	Use of hydrogen chloride fumes as a disinfectant.
1774	Preparation of chlorine gas. Definition of chlorine as dephlogisticated muriatic acid.
1785	Observation of chlorine hydrate, use of chlorine as a bleaching agent - definition of chlorine as oxymuriatic acid.
1798	First patent of chlorine bleaching solutions.
1800	Decomposition of hydrogen chloride electric parts.
1801	Development of chlorine generator for sanitation purposes.
1809	Consideration of element character for chlorine.
1810	Definition of chlorine as a chemical element - hydrate character ascertained for chlorine hydrate.

1813	Coinage of the term 'chlorine'.
1815	General acceptance of the element character for chlorine.
1819	Hydrogen chloride defined as a hydrate of the hypothetical muriatic acid.
1823	Quantitative determination of the composition of chlorine hydrate - installation of disinfecting equipment using chlorine in hospitals.
1826	Chlorine water used in obstetric wards for the poerention of puerperal fever.
1831	Fumigetion with chlorine during the great European cholera epidemic.

McBee, E.T. and Belonlar, L.R. "Discovery And Early Work"

Source : Sconce, J. D., "Chlorine, Its Manufacture, Properties and Uses", Reinhold Publishing Corporation, Ney York, 1968, pp. 3-9.

APPENDIX II

CONCEPT OF MARKETING AND MARKETING ORIENTATIONS

APPENDIX II

CONCEPT OF MARKETING AND MARKETING ORIENTATIONS

There are about as many definitions of marketing as there are writers[1-6]. It has been variously described as a "business activity", as a "group of related business activities", as a "trade phenomenon", as a "frame of mind", as a "coordinative integrated function in policy making", as a "sense of business purpose", as an "economic process", as a "structure of institutions", as a "process of exchanging or transfering ownership of products", as a "process of concentration, equalization and dispersion", as a "creation of time, place and possession of utilities", as a "process of demand and supply adjustments", and many other things. Each one of these definitions has a core of significance imbibed into it. However, the one provided by Kotler is nearer to our purpose : "Marketing is human activity directed at satisfying needs and wants through an exchange process"[7].

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1. Marketing Staff of the Ohio State University, "A Statement of Marketing Philosophies", Journal of Marketing, Jan. 1965, p. 43.
2. Alexander Ralph S., and the Committee on Definitions, "Marketing Definitions", American Marketing Association, Chicago, 1961, p. 15.
3. Kotler Phillip, "Marketing Management - Analysis Planning and Control", 3rd Ed., Prentice Hall of India, 1976, p.4.
4. Drucker Peter F., "The Practice of Management", Harper & Row Publishers, Incorporated, New York, 1954, pp. 37-41.
5. Condiff Edward W., Still Richard R., Govoni, Norman A.P., "Fundamentals of Modern Marketing", Prentice Hall of India Private Limited, New Delhi, 1974, pp. 3-6.

In this exchange process it is important to note the relative weight given to the interests of the organisation, the customers and the society. Very often these conflict. Four alternative concepts under which business and other organisations can conduct these marketing activities can be described[8] as :

(a) The Product Concept : a management orientation that assumes that consumers will respond favourably to good products that are reasonably priced and that little company marketing effort is required to achieve satisfactory sales and profits.

(b) The Selling Concept : a management orientation that assumes that consumers will normally not buy enough of the company's products unless they are approached with a substantial selling and promotional effort.

(c) The Marketing Concept : a management orientation that holds that the key task of the organisation is to determine the needs, wants and values of a target market and to adapt the organisation to delivering the desired satisfactions more effectively and efficiently than its competitors.

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6. Dodge Robert H., "Industrial Marketing", McGraw-Hill Book Company, New York, 1970, p. 4.
7. Phillip Kotler, "Marketing Management - Analysis, Planning and Control", 3rd Ed., Prentice Hall of India, 1970, p. 5.
8. Ibid., p. 5.

In recent years a number of questions have been raised about marketing concept. One of the major questions is whether the marketing concept is really being practised by business firms. The marketing concept has such a nice sounding rhetoric when used by businessmen in their speeches. Though they may perhaps even mean what they say, yet there is a great deal to do in between the utterance and the deed. Establishing the marketing concept in an organisation is an extremely difficult task, and it takes considerable planning, persuasion, education and reorganisation[1].

Drucker considers consumerism to be an evidence of this : "That after twenty years of marketing rhetoric consumerism could become a powerful and popular movement proves that not much marketing has been practised. Consumerism is the "shame of marketing" [2].

The other disturbing question about the marketing concept relates to its validity rather than its practice. Recently articles have appeared with such titles as "The Faltering Marketing Concept" and "Societal Adaptation : A

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1. Edward Mikay, "The Marketing Mystique", New York, American Management Association, 1972, pp. 22-30.
2. Drucker Peter F., "Management Tasks, Responsibilities, Practices", New York, Harper & Row Publishers, 1973, p. 64.

New Challange for Marketing"[1]. These articles essentially raise the question of whether the marketing concept is any lenger an appropriate organisational goal in an age of deteriorating environment, population growth, resource shortages, world-wide inflation and neglected social services. The marketing concept overlooks the individual wants satisfaction and long term public interest. There have been several instances of charges levelled against industry and business in this regard by consumers and environmental groups.

For example, take the detergents. The detergent industry has catered to the passion for whiter and clearner clothes by offering the product but at the same time it pollutes rivers and streams, killing fish and injuring the recreational possibilities. Various such other instances can be cited in this regard. These situations have led in recent years to the call to revise or replace the marketing concept. Among the proposals are "the human concept", "the intelligent consumption concept", and "the ecological imperative concept" - all of which get at a different aspect

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1. Martin L. Bell and Emery Willion C. "The Faltering Marketing Concept", Journal of Marketing, October 1971, pp. 37-42; and Laurence P. Feldman, "Societal Adaptation : A New Challange for Marketing", Journal of Marketing, July 1971, pp. 54-60.

of the same problem[1-3]. Kotler's societal concept seems to suggest an answer to the prevailing dilemma :

(d) The Societal Marketing Concept : a management orientation aimed at generating consumer satisfaction and long-term consumer and public welfare as the key to satisfying organisational goals and responsibilities[4].

The chief merit of this concept is that it significantly adds the important considerations of long run consumer and public welfare and calls for a shift of the organisations' perspective to include more marketing participants and long run effects.

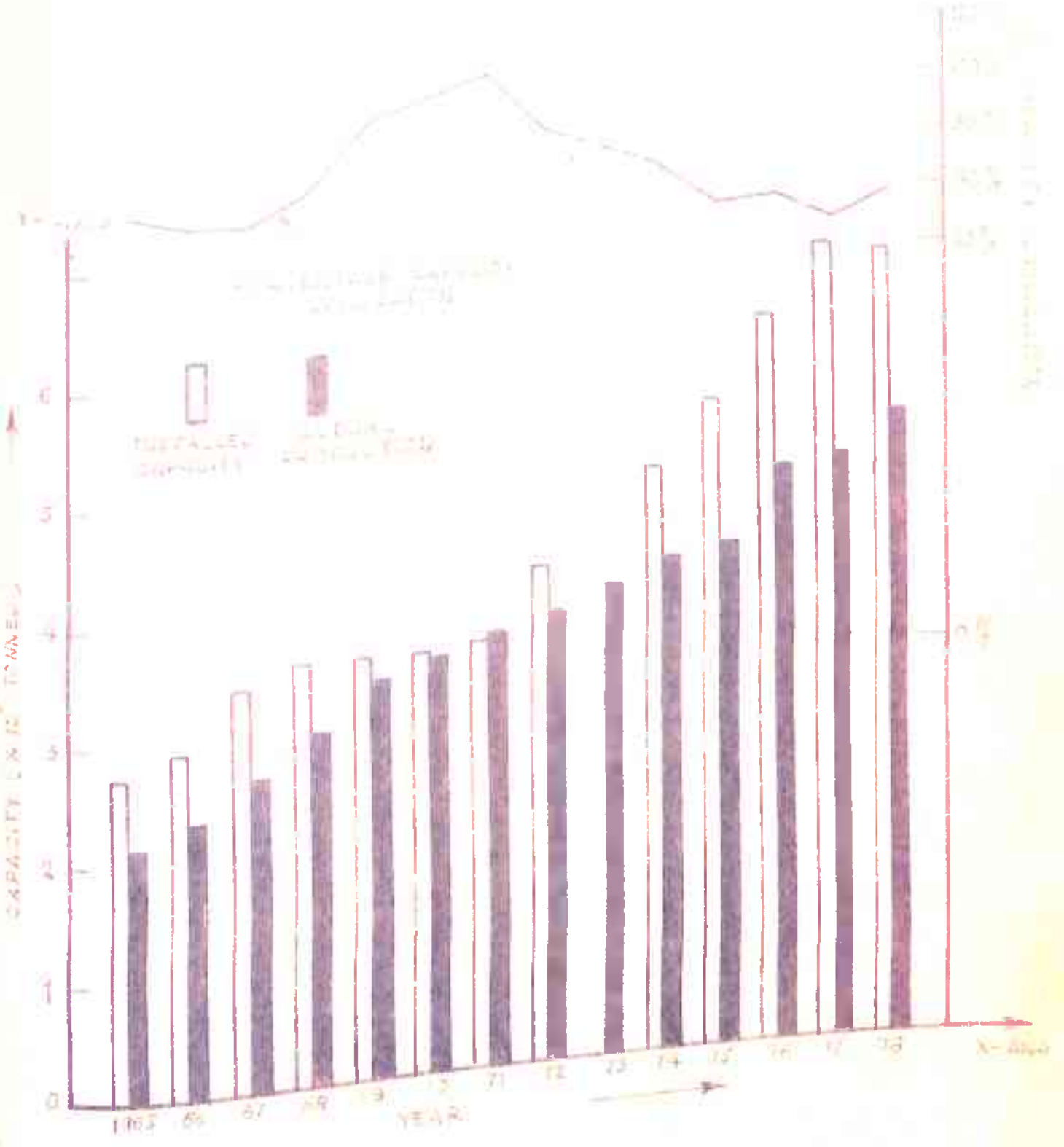
Reviewing the role of chlor-alkali industry in this context calls for adaptation of a marketing orientation that incorporates long-term consumer and public welfare as the key to satisfy industry goals and responsibilities. With respect to chlor-alkali industry this can only be achieved by planning the economic and profitable use of chlorine produced along with caustic-soda, and discovering ways of enabling the industry to perform its role in the development of the nation in a responsible manner.

---

1. Leslie M. Dawson, "The Human Concept - New Philosophy for Business", Business Horizons, December, 1969, pp. 29-38.
2. Rothe James T. and Lissa Benson, "Intelligent Consumption - An Attractive Alternative to the Marketing Concept", MSU Business Topics, Winter, 1974, pp. 29-54.
3. George Fish, "Criteria for a Theory of Responsible consumption", Journal of Marketing, April, 1973, pp. 24-31.
4. Kotler Phillip, "Marketing Management - Analysis, Planning and Control", 3rd Ed., Prentice Hall of India, 1970, p.16.

APPENDIX III

ACQUIRED DATA



CAUSTIC SODA

BLE 5.2

CAUSTIC-SODA

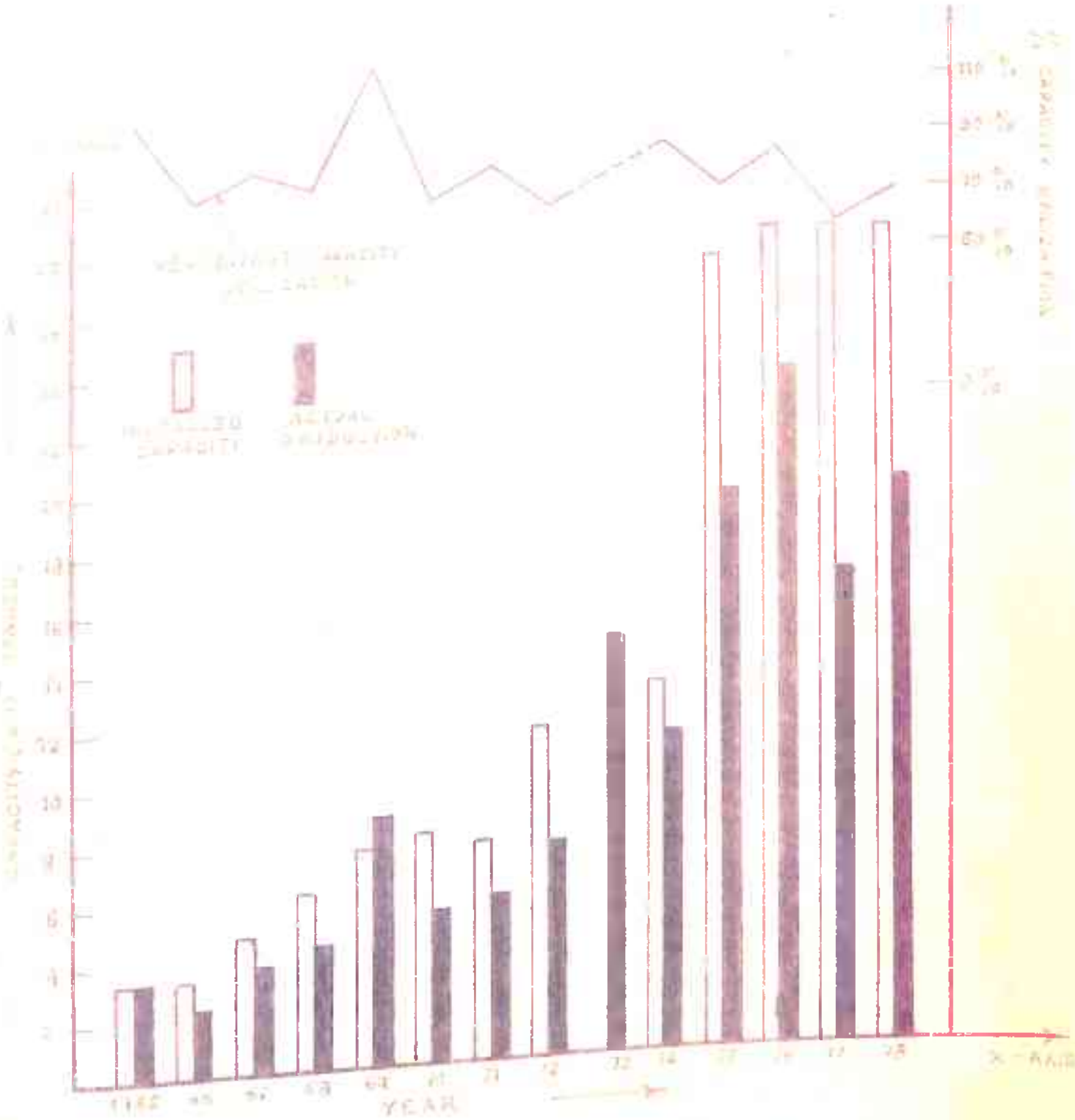
ACQUIRED DATA

YEAR	PRODUCTION (TONS)	CHLORINE PRODUCTION	GROWTH-RATE (PERCENTAGE)
1965	214955.0	189160.4	--
1966	230459.0	202803.9	7.21
1967	269342.0	237020.9	16.87
1968	305906.0	269197.3	13.57
1969	346410.0	304840.8	13.24
1970	361450.0	318076.0	4.34
1971	376634.0	331437.9	4.20
1972	391078.0	344148.6	3.83
1973	410544.0	361278.7	4.97
1974	431550.0	379764.0	5.11
1975	442600.0	389540.8	2.57
1976	504100.0	443608.0	13.87
1977	517000.0	454960.0	2.55
1978	548000.0	482240.0	5.99
1979	566839.0	498818.3	3.43
1980	549120.0	483225.6	-3.12
AVERAGE	404128.0	355632.31	6.57
STD. DEV.	113446.0	99832.51	5.42

FOR A STRAIGHT LINE LEAST SQUARE FIT

REGRESSION CO-EFFICIENT = 23594.9766

CONSTANT = 203570.7191



HYDROCHLORIC ACID

TABLE 5.4

HYDROCHLORIC ACID

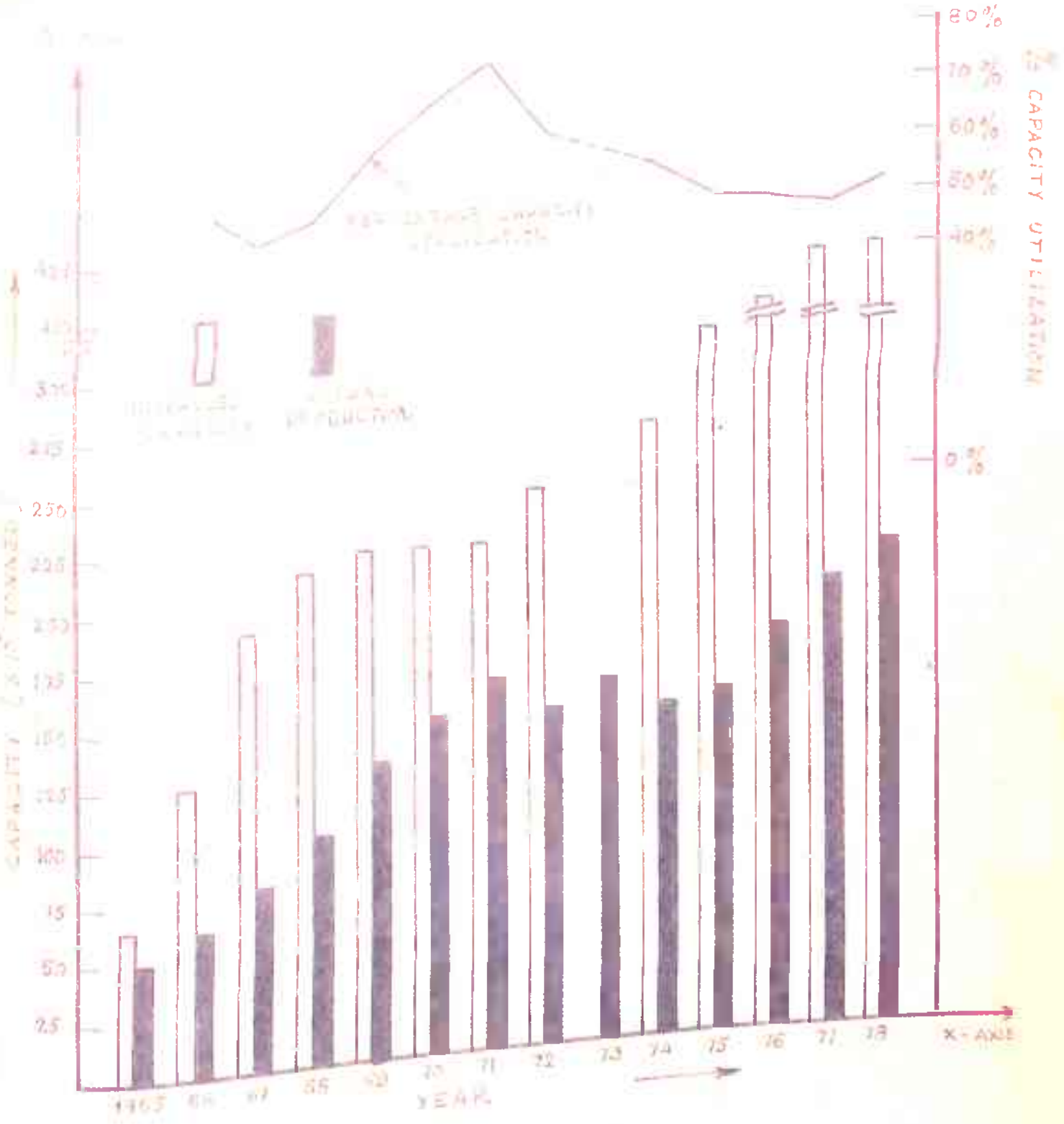
ACQUIRED DATA

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1965	33435.0	10030.5	--
1966	23050.0	7154.9	-28.66
1967	37718.0	11315.3	58.14
1968	44861.0	13458.2	18.93
1969	85839.0	25751.6	91.34
1970	54487.0	16346.0	-36.52
1971	69109.0	20732.6	26.83
1972	74000.0	22200.0	7.07
1973	143818.0	43145.3	94.34
1974	110000.0	33000.0	-23.51
1975	193400.0	58019.9	75.81
1976	235000.0	70500.0	21.50
1977	165000.0	49499.9	-29.78
1978	198740.0	59621.9	20.44
1979	223600.0	67080.0	12.50
1980	132000.0	39600.0	-40.96
AVERAGE	114053.57	34216.0	17.33
STD. DEV.	71710.21	21513.0	45.54

FOR A STRAIGHT LINE LEAST SQUARE FIT

REGRESSION CO-EFFICIENT = 13027.7851

CONSTANT = 3317.4067



LIQUID CHLORINE

TABLE 5.6

LIQUID CHLORINE

ACQUIRED DATA

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1965	52037.0	51037.0	--
1966	62384.0	62384.0	22.23
1967	81036.0	81036.0	29.88
1968	100038.0	100038.0	23.46
1969	129352.0	129352.0	29.30
1970	147045.0	147045.0	13.67
1971	162442.0	162442.0	10.47
1972	147455.0	147455.0	-9.21
1973	157904.0	157904.0	7.07
1974	147600.0	147600.0	-6.52
1975	161900.0	161900.0	9.68
1976	180300.0	180300.0	11.36
1977	200600.0	200600.0	11.25
1978	218800.0	218800.0	9.07
1979	215600.0	215600.0	-1.46
1980	227300.0	227300.0	5.42
AVERAGE	149424.59	149424.59	11.04
STD. DEV.	54169.60	54169.60	11.66

FOR A STRAIGHT LINE LEAST SQUARE FIT

REGRESSION CO-EFFICIENT = 10960.5039

CONSTANT = 56260.3047

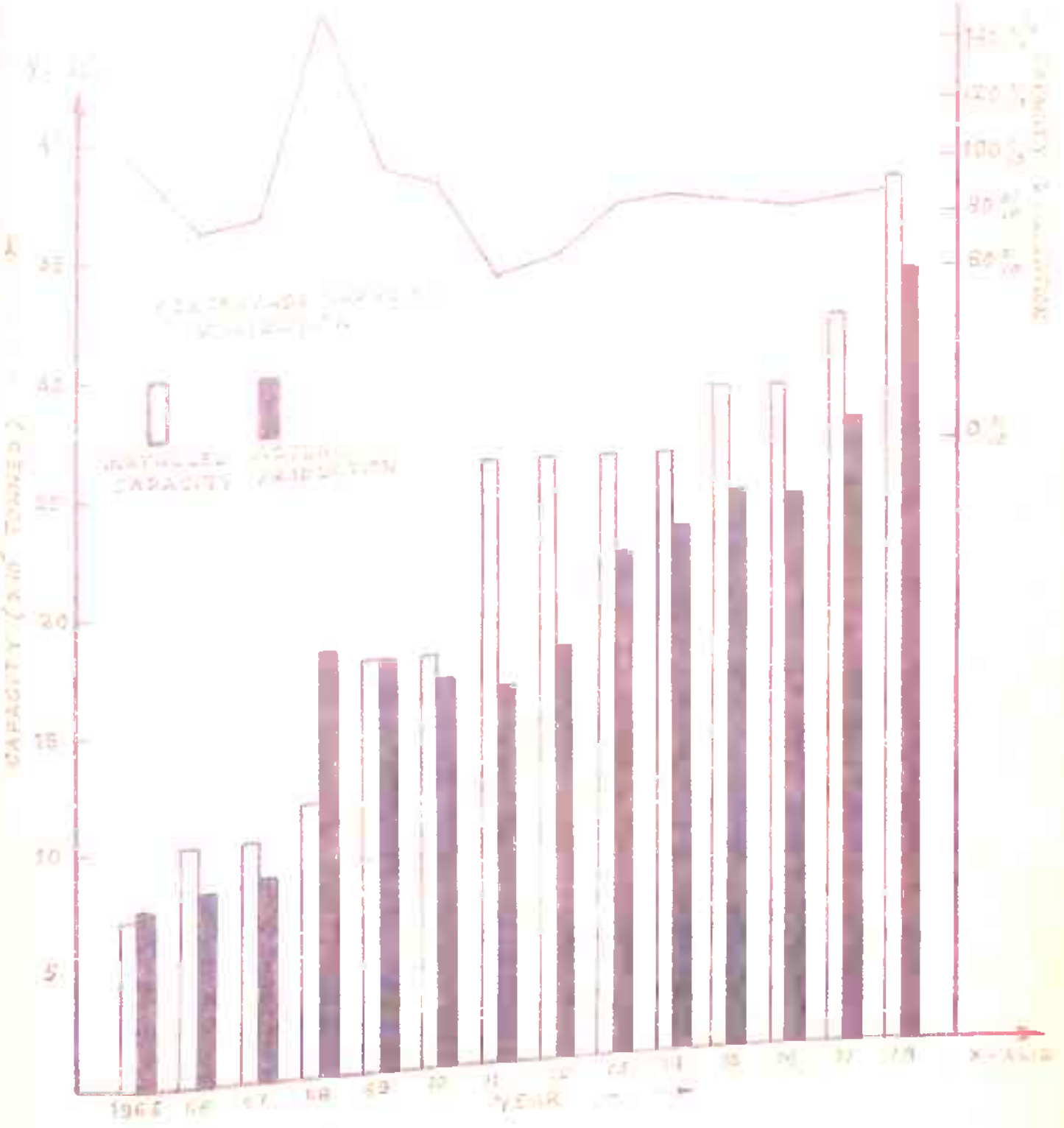

CAPACITY (A.I.D.) TONNES
YEAR
BENZENE HEXA CHLORIDE

TABLE 5.8

BENZENE HEXACHLORIDE

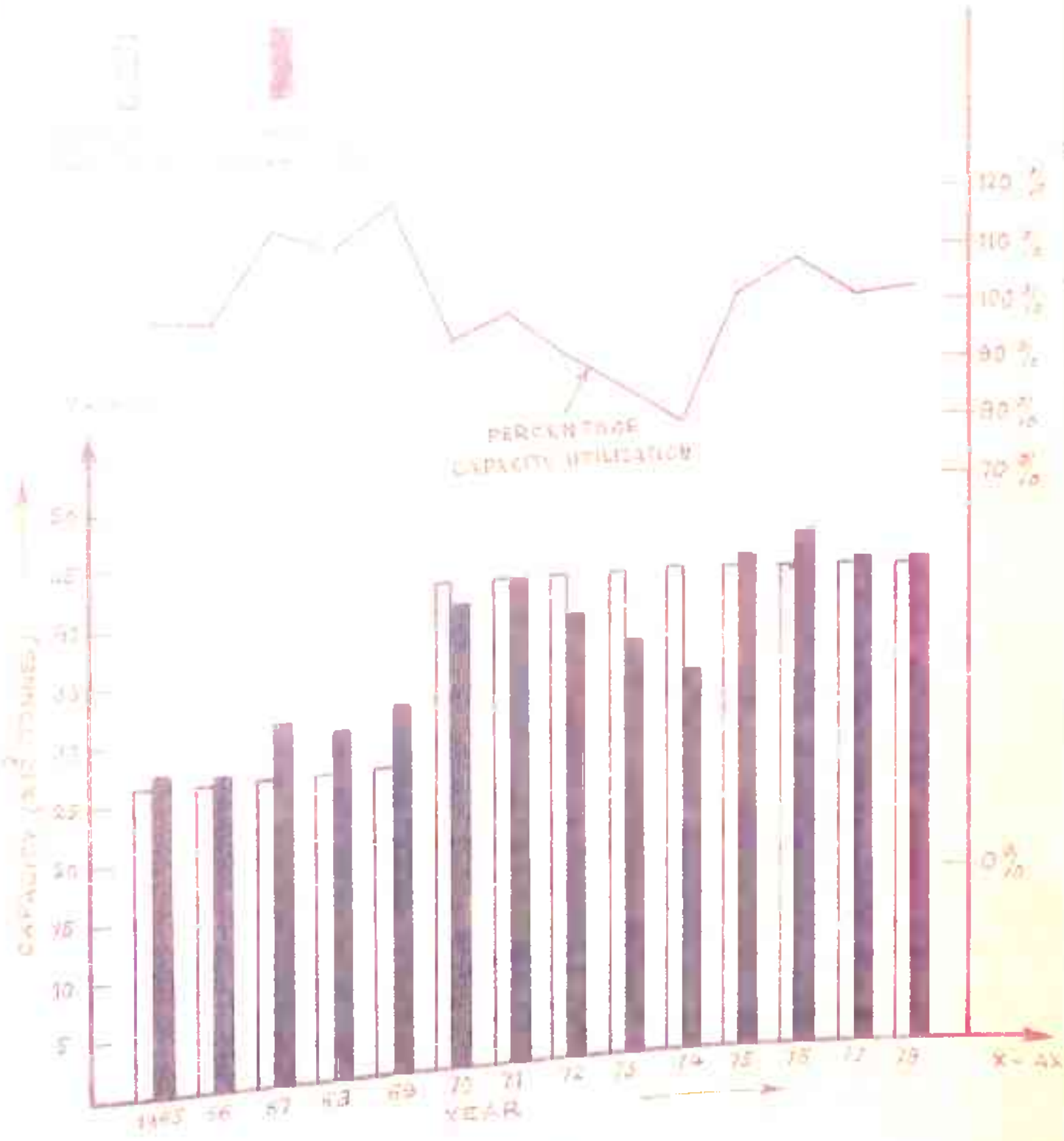
ACQUIRED DATA

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1965	7441.0	6696.9	--
1966	8277.0	7449.2	11.23
1967	8669.0	7802.1	4.73
1968	18182.0	16363.8	109 .73
1969	17800.0	16020.0	-2.10
1970	16500.0	14850.0	-7.30
1971	16517.0	14865.3	0.10
1972	17730.0	15957.0	7.34
1973	21819.0	19637.1	23.06
1974	22738.0	20464.2	4.21
1975	24298.0	21868.2	6.86
1976	23956.0	21560.4	-1.40
1977	27205.0	24484.5	13.56
1978	33643.0	30278.6	23.66
1979	34300.0	30870.0	1.95
1980	28413.0	25571.7	-17.16
AVERAGE	20468.0	18421.19	11.89
STD. DEV.	8229.87	7406.88	29.05

FOR A STRAIGHT LINE LEAST SQUARE FIT

REGRESSION CO-EFFICIENT = 1637.6970

CONSTANT = 6547.5791


PERCENTAGE
CAPACITY UTILISATION
120 %
100 %
90 %
80 %
70 %
0 %
5
10
15
20
25
30
35
40
45
50
1965
66
67
68
69
70
71
72
73
74
75
76
77
78
YEAR
X - AXIS

D. D. T.

TABLE 5.10

D.D.T.

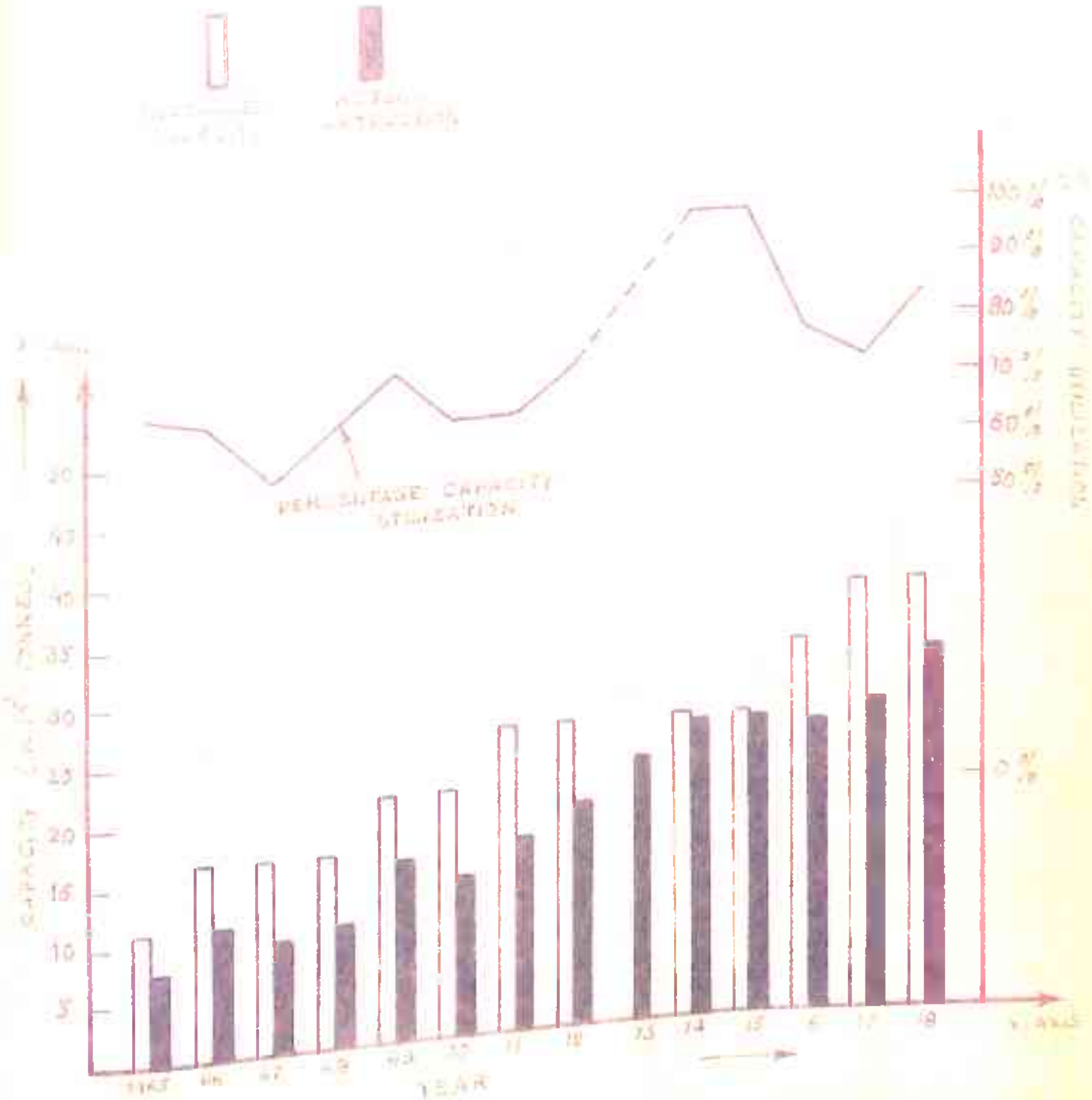
ACQUIRED DATA

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1965	2745.0	4117.5	--
1966	2723.0	4084.5	-0.80
1967	3132.0	4698.0	15.02
1968	3012.0	4518.0	-3.83
1969	3200.0	4800.0	6.24
1970	4000.0	6000.0	25.00
1971	4116.0	6174.0	2 .90
1972	3838.0	5757.0	-6.75
1973	3578.0	5367.0	-6.77
1974	3324.0	4986.0	-7.09
1975	4360.0	6540.0	31.16
1976	4527.0	6790.5	3.83
1977	4243.0	6364.5	-6.27
1978	4284.0	6426.0	0.96
1979	4828.0	7242.0	12.69
1980	4088.0	6132.0	-15.32
AVERAGE	3749.87	5624.81	3.39
STD. DEV.	657.74	986.61	12.83

FOR A STRAIGHT LINE LEAST SQUARE FIT

REGRESSION CO-EFFICIENT = 117.2264

CONSTANT = 2753.4506



BLEACHING POWDER

TABLE 5.12

STABLE BLEACHING POWDER

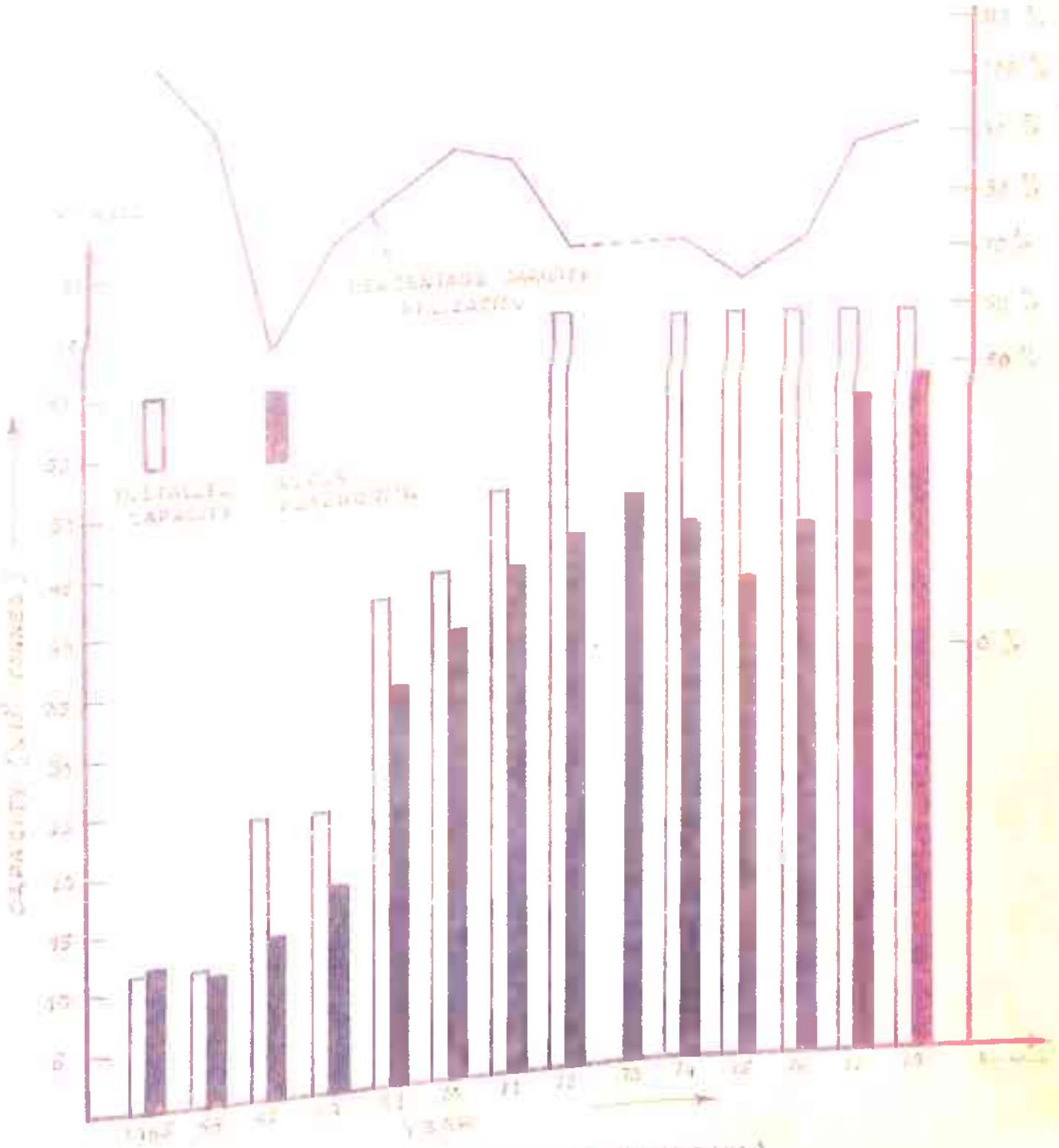
ACQUIRED DATA

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1965	7359.0	2943.6	--
1966	10809.0	4323.6	46.88
1967	9249.0	3699.6	-14.43
1968	10500.0	4200.0	13.52
1969	15693.0	6277.2	49.45
1970	13744.0	5497.6	-12.41
1971	16718.0	6687.2	21.63
1972	18830.0	7532.0	12.63
1973	22724.0	9089.5	20.67
1974	25300.0	10120.0	11.33
1975	25300.0	10120.0	0.00
1976	24700.0	9080.0	-2.37
1977	26700.0	10680.0	8.09
1978	30900.0	12360.0	15.73
1979	32100.0	12940.0	3.88
1980	33800.0	13520.0	5.29
AVERAGE	20276.62	8110.64	11.99
STD. DEV.	8582.72	3433.08	18.08

FOR A STRAIGHT LINE LEAST SQUARE FIT

REGRESSION CO-EFFICIENT = 1776.2177

CONSTANT = 5178.7783



POLY VENYL CHLORIDE (RESIN)

TABLE 5.14

POLYVINYL CHLORIDE

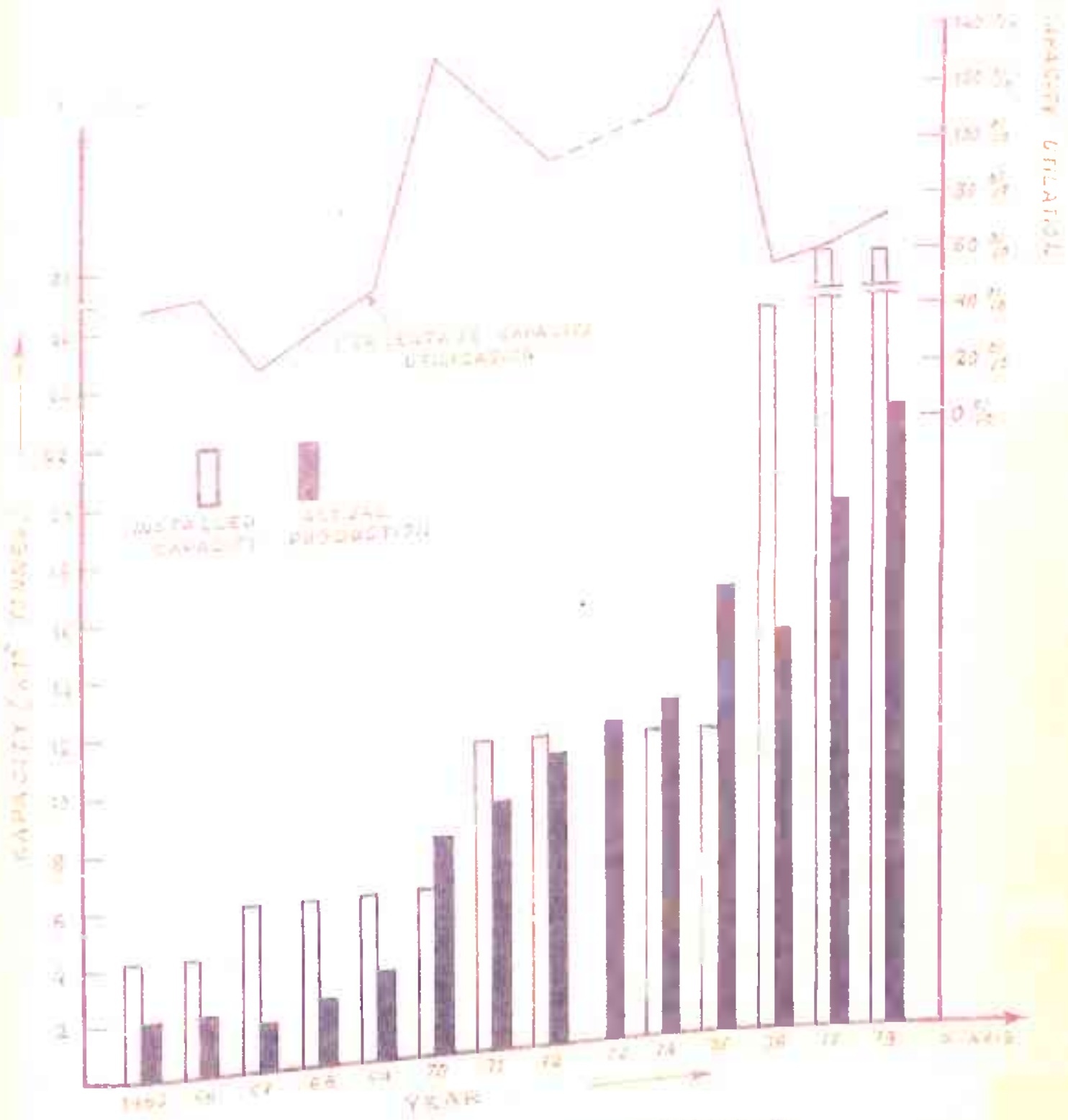
ACQUIRED DATA

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1965	12179.0	9134.2	--
1966	10796.0	8097.0	-11.35
1967	13611.0	10208.2	26.07
1968	17595.0	13196.2	29.27
1969	33957.0	25392.7	92.42
1970	39678.0	29008.5	14.23
1971	42320.0	31740.0	9.41
1972	46189.0	34641.7	9.14
1973	49996.0	36747.0	6.07
1974	46290.0	34717.5	-5.52
1975	41524.0	31143.0	-10.29
1976	45854.0	34390.5	10.42
1977	56993.0	42744.7	24.29
1978	59077.0	44307.7	3.65
1979	59246.0	44434.5	0.28
1980	38264.0	28698.0	-35.41
AVERAGE	38216.82	28662.61	10.84
STD. DEV.	16412.87	12309.65	27.97

FOR A STRAIGHT LINE LEAST SQUARE FIT

REGRESSION CO-EFFICIENT = 2924.6430

CONSTANT = 13357.3535



PHOSPHORUS TRICHLORIDE

TABLE 5.16

PHOSPHORUS TRICHLORIDE

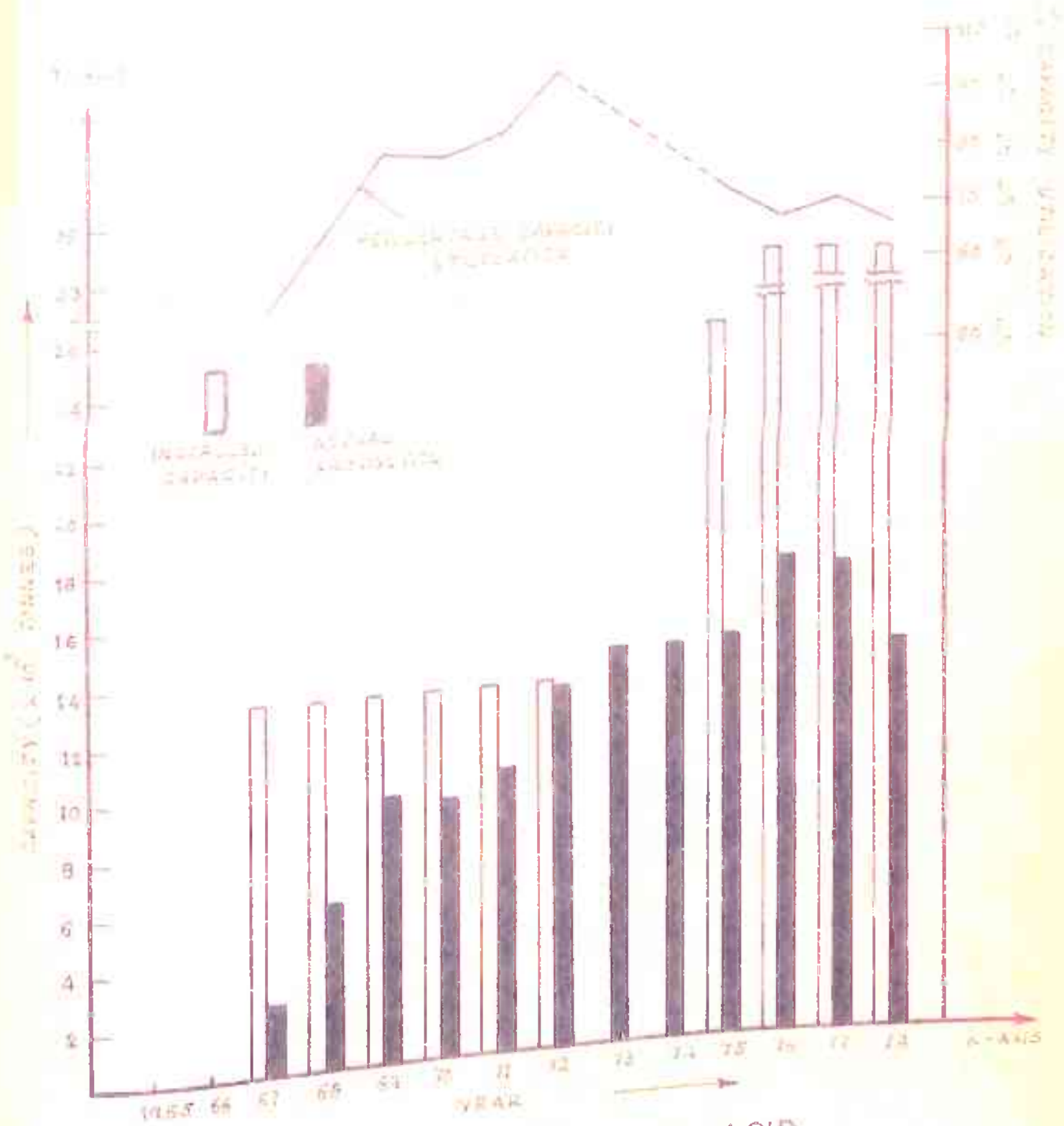
ACQUIRED DATA

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1965	200.0	154.0	--
1966	217.0	167.0	8.50
1967	160.0	123.2	-26.26
1968	233.0	179.4	45.62
1969	316.0	243.3	35.62
1970	786.0	605.2	148.73
1971	888.0	683.7	12.97
1972	1039.0	800.0	17.00
1973	1131.0	870.8	8.85
1974	1121.0	863.1	-0.88
1975	1595.0	1228.1	42.28
1976	1445.0	1112.6	-9.40
1977	1898.0	1461.4	31.34
1978	2250.0	1732.5	18.56
1979	1500.0	1155.0	-33.33
1980	2000.0	1540.0	33.33
AVERAGE	1048.68	807.48	22.19
STD. DEV.	694.71	534.93	42.09

FOR A STRAIGHT LINE LEAST SQUARE FIT

REGRESSION CO-EFFICIENT = 138.8132

CONSTANT = -131.2246



CHLOROSULPHONIC ACID

TABLE 5.18

CHLOROSULPHONIC ACID

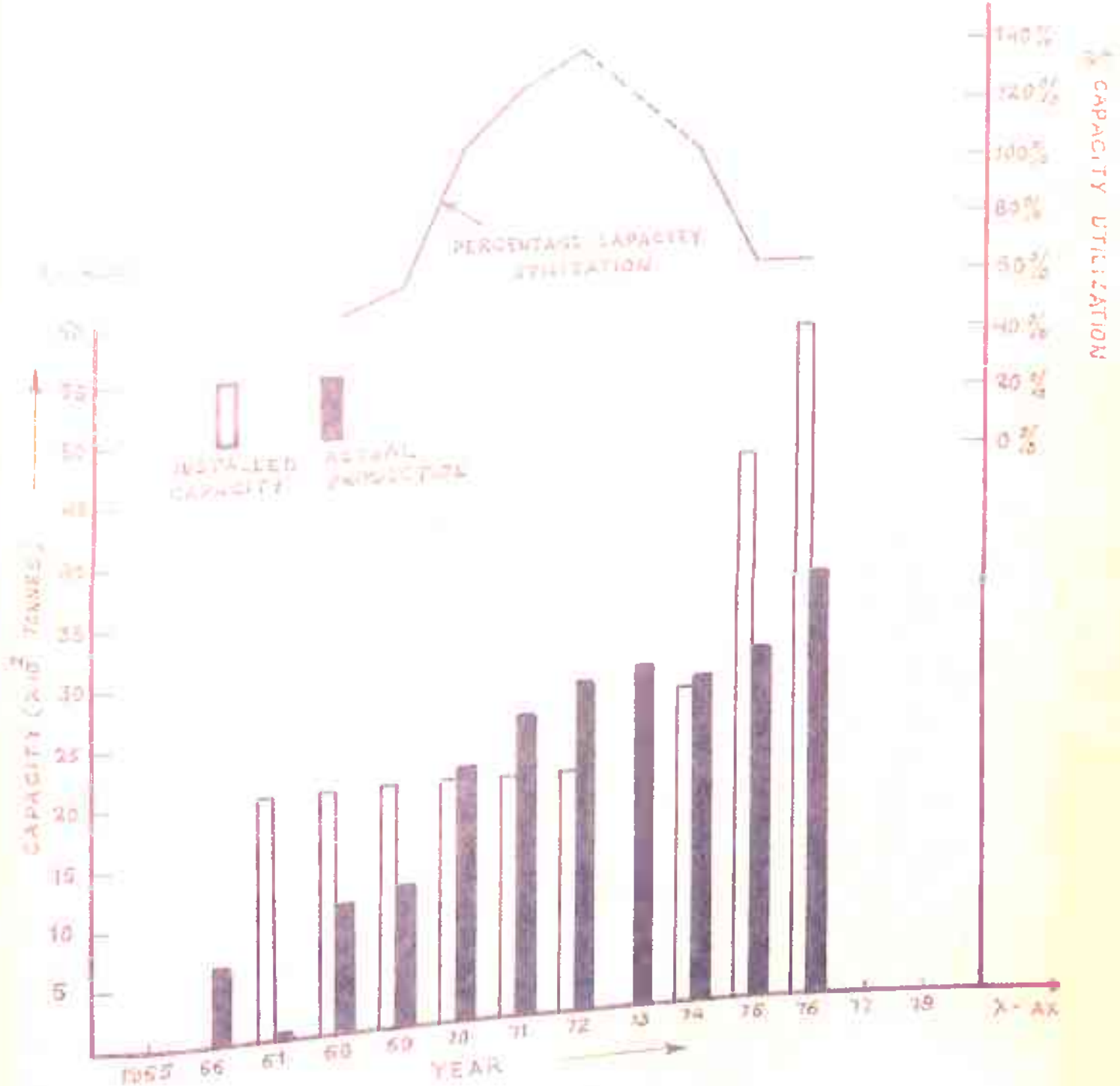
ACQUIRED DATA

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1965	N.A.	N.A.	--
1966	2305.0	691.5	--
1967	2521.0	756.2	9.37
1968	5905.0	1771.4	134.23
1969	9576.0	2872.7	62.16
1970	9291.0	2787.2	-2.97
1971	10264.0	3079.1	10.47
1972	12967.0	3890.0	26.33
1973	14187.0	4256.0	9.40
1974	14253.0	4275.8	0.46
1975	14501.0	4350.2	1.73
1976	15265.0	4579.5	5.26
1977	17100.0	5130.0	12.02
1978	14100.0	4230.0	-17.54
1979	16000.0	4800.0	13.47
1980	19000.0	5700.0	18.75
AVERAGE	11815.66	3544.69	20.22
STD. DEV.	5069.80	1520.94	37.37

FOR A STRAIGHT LINE LEAST SQUARE FIT

REGRESSION CO-EFFICIENT = 1058.8994

CONSTANT = 3344.4731



MONO CHLORO ACETIC ACID

TABLE 5.20

MONOCHLORO ACETIC ACID

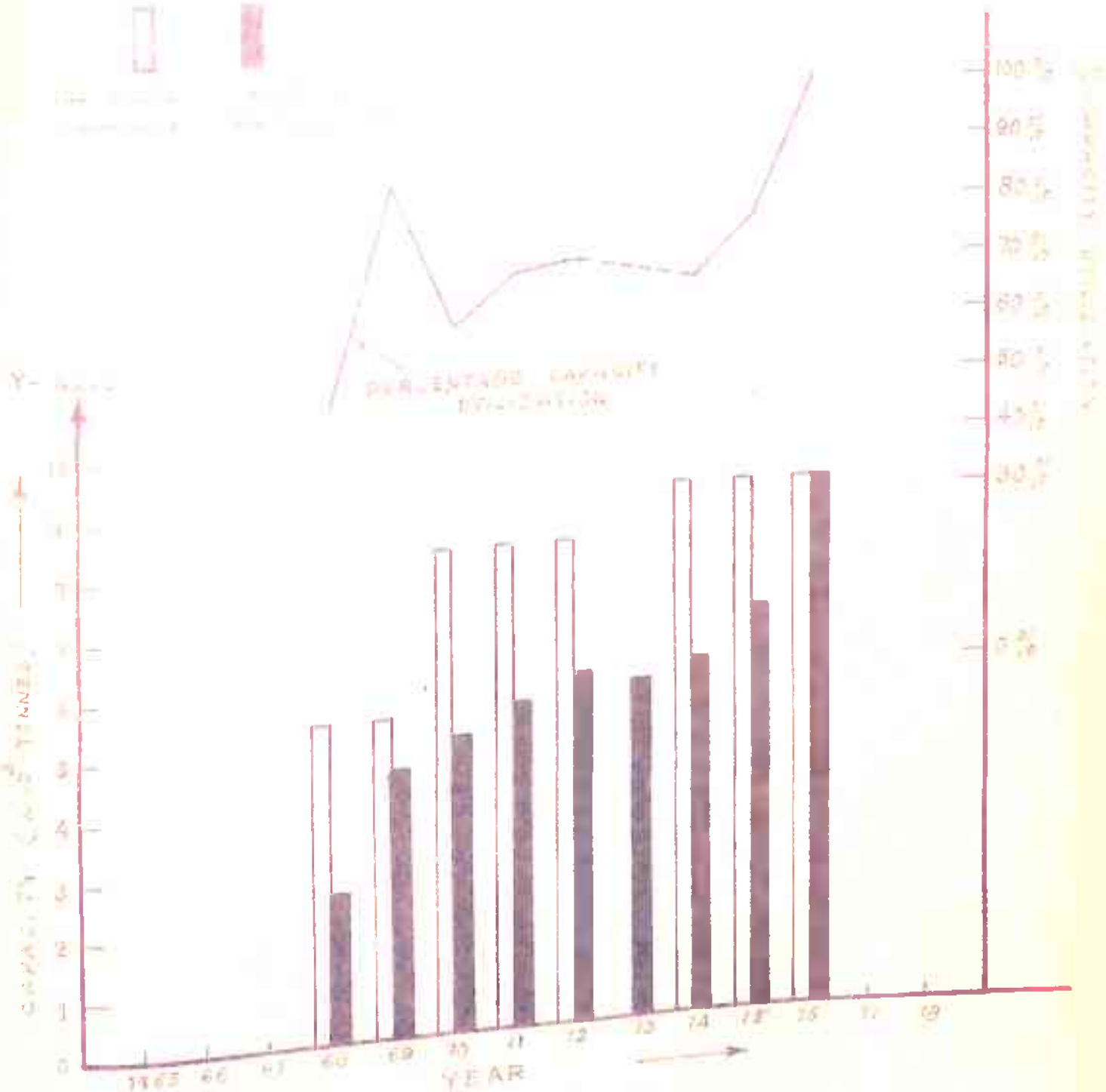
ACQUIRED DATA

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1965	N.A.	N.A.	--
1966	647.0	245.8	--
1967	44.0	16.7	-93.19
1968	1083.0	411.5	2361 .36
1969	1210.0	459.8	11.72
1970	2155.0	818.9	78.09
1971	2545.0	967.1	18.09
1972	2800.0	1064.0	10.01
1973	2792.0	1060.9	-0.28
1974	2900.0	1064.0	0.28
1975	2998.0	1311.2	7.07
1976	3652.0	1387.7	21.81
1977	5100.0	1938.0	39.64
1978	5100.0	1938.0	0.00
1979	N.A.	N.A.	--
1980	N.A.	N.A.	--
AVERAGE	2532.76	962.45	204.55
STD. DEV.	1543.93	586.69	680.33

FOR A STRAIGHT LINE LEAST SQUARE FIT

REGRESSION CO-EFFICIENT = 380.0821

CONSTANT = -127.8051



CARBON TETRA CHLORIDE

TABLE 5.22

CARBON TETRACHLORIDE

ACQUIRED DATA

YEAR	PRODUCTION (TONS)	CHLORINE UTILIZATION	GROWTH-RATE (PERCENTAGE)
1965	N.A.	N.A.	--
1966	N.A.	N.A.	--
1967	N.A.	529.4	--
1968	2647.0	930.5	75.73
1969	4653.0	1020.4	9.64
1970	5102.0	1145.6	12.26
1971	5728.0	1200.1	4.76
1972	6001.0	1153.1	-3.91
1973	5766.0	1223.6	6.10
1974	6118.0	1400.0	14.41
1975	7000.0	1836.0	31.14
1976	9180.0	1540.0	-16.12
1977	7700.0	2020.0	31.16
1978	10100.0	N.A.	--
1979	N.A.	N.A.	--
1980	N.A.		
AVERAGE	6363.18	1272.63	16.52
STD. DEV.	2082.48	416.49	25.25

FOR A STRAIGHT LINE LEAST SQUARE FIT

REGRESSION COEFFICIENT = 584.9816

CONSTANT = 2853.2929

APPENDIX IV

LISTING PROGRAMME : FORECASTING TECHNIQUE

```
// JOB
LOG DRIVE   CART [illegible]   CART  V  [illegible]   PHY DRIV
VI  V  [illegible]  CONFIG  K
// FOR
*LIST SOURCE PROGRAM
*ONE WORD INTEGERS
      SUBROUTINE AVNSD(X,N,XBAR,SIGM)
      DIMENSION X(1)
C ----------------------------------------------------------------------
C     THIS SUBROUTINE CALCULATES THE MEAN AND STANDARD DEVIATION OF ARRAY
C     X OF DIMENSION N.
C ----------------------------------------------------------------------
      SUM=0.0
      DO 1 I=1,N
    1 SUM=SUM+X(I)
      [illegible]
      XBAR=SUM/N
      SUM=0.
      DO 2 I=1,N
      [illegible]=X(I)-XBAR
      [illegible]
      SUM=SUM+[illegible]
    2 CONTINUE
      SIGM=SUM/(N-1)
      SIGM=SQRT(SIGM)
      RETURN
      END

FEATURES SUPPORTED
 ONE WORD INTEGERS

CORE REQUIREMENTS FOR AVNSD
 COMMON        0  VARIABLES               PROGRAM      [illegible]

RELATIVE ENTRY POINT ADDRESS IS [illegible] (HEX)

END OF COMPILATION

// DUP

*STORE        WS  UA  AVNSD
D 0[illegible] ENTRY POINT NAME ALREADY IN LET/FLET


// FOR
*LIST ALL
*ONE WORD INTEGERS
      SUBROUTINE MARIV(A,I,J,INDEX)
      DIMENSION A(1)
      RETURN
      END

FEATURES SUPPORTED
 ONE WORD INTEGERS

CALLED SUBPROGRAMS
 SUBIN

CORE REQUIREMENTS FOR MARIV
 COMMON        0  VARIABLES               PROGRAM      [illegible]

RELATIVE ENTRY POINT ADDRESS IS 0000 (HEX)

END OF COMPILATION

// DUP
[illegible]              M RIV
```

```
      WRITE (  ,  )IB  S,X(I,2),UTZ(I)
      WRITE (  ,  )IBUSE,X(I,2),UTZ(I),GRONR(I)
      CONTINUE
      DO  J=  ,M
      SUM(J)=0.0
      DO  I=  ,M
      SUM(J)=SUM(J)+X(I,J)
      CONTINUE
      DO  I=  ,M
      VG(I)=SUM(I)/M
      CONTINUE
      WRITE (  ,  )
      CALL AVSD(UTZ,M,AVG1,SD1)
      CALL AVSD(Z,M,AVG2,SD2)
      CALL AVSD(  ),AVG1,AVG
      WRITE (  ,  )
      WRITE (  ,  )
      CALL AVSD(  ),SD1,SD2
      WRITE (  ,  )
      WRITE (  ,  )
      IF(IND-1)  ,  ,  
      WRITE (  ,  )
      FORM  T(' ',//,' ',X,'CORELATION BETWEEN CHLORINE',/,' ',X,'AVAILABILITY AND
     &GNP',//,20X,'YEAR',20X,'NU  OF TI
     &ITY',//)
```

```
IY  I=     +I
         I=  ,
WRIT  (  ,    ),Y  ,   (I),  L(  )
WRITE(  ,    )(///   ,       ,     ///   )
RILI Y
              J=  ,
X (I,J)=X(I,J)    VG(J)
L=
              I=  ,L
              J=  ,L
H(I,J)=
              K=  ,N
H(I,J)=H(I,J)+X (K,I)*X (K,J)
              I=  ,N
Y (I)=X  (I,N)
              J=  ,L
XY(J)=
DO  9         I=  ,N
XY(J)=XY(J)+X (I,J)*Y (I)
I (L    )9  ,9  ,9
 ( ,  )=    /(H(  ,1))
CALL  M   V(H,L,L,INDEX)
IF(I  EX)99,9  ,99
DO  9        I=  ,L
DO  9        J=  ,L
C(I,J)=H(I,J)
CONTINU
DO      I=  ,L
B(I)=0.
              J=1,L
B(I)=B(I)+C(I,J)*XY(J)
CONTINU
    =0.
DO          J=  ,L
    =    +  VG(J)*B(J)
CONTINU
CONS=  VG(N)-
WRIT  (  ,    )(B(I),I=1,L),
WRIT  (  ,  9)   ITL (I),I=1,
WRIT  (  ,  )(
WRIT  (  , 05)
WRIT  (  ,    )
WRIT  (  ,   2)
WRIT  (  ,    )
WRIT  (  ,  03)
WRIT  (  ,  04)
WRIT  (  ,  03)
MV=M
M=M+  C
DO      I=  ,2
IIX(I)=  9 4+I
YC L(I)=  .
DO      J=  ,L
IF(I  MV)149,  0,14
X(I,J)=X(I-  ,J)*X(I,J)+CONS
YCAL(I)=B(J)*X(I,J)  L(I)
UTZ(I)=F CTP*YC  L(I)
CONTINU
IF(I  E  )99,    ,50
DO 2      I=  ,24
CCL  (I)=UTZ(I)
CONTINU
GO  TO
MM=  989-IBAS
DO  2  0I=  ,MM
J=IB  S   96 +I
CCUD(J)=CCUD(J)+UTZ(I)
CONTINU
MM=M
DO 6  I=  ,23
GROWR(I+1)=(YC L(I+1)-YCAL(I))*100./YCAL(I)
KV=M
CONTINU
WRIT  (  ,    )IB  ,YC L( ),UTZ( )
DO      I=2,MV
IBASE=IB  S+I
WRIT  (  , 06)IBASE,YC L(I),UTZ(I),GROWR(I)
CONTINU
WRIT  (  ,    )
```

```
      CALL  V  D(Y   ,  V,  V   ,  )
      CALL  V  D(  ,  V,  /C  ,  )
      CALL  V  D(Z, V  , VG  ,
      WRITE  (  ,   ) VCR  ,  V   ,  V
      WRITE  (  ,   )
      WRITE  (  ,   )    ,SD  ,SD
      WRITE  (  ,   )
      M=
              ,  V
      YC (  )=X(I,  )
 30   CONTINUE
      SUM=
      DO
      SUM=   +(YC (  )-YCAL(I))**
 40   CONTINUE
      REM
      SE=SQRT(  M/K)
      DO       ,L
      CC(I)=   C(I,I)**
      CONTINUE
      SUM1=
      DO       =1,L
      SUM1=SUM1+ (I)*XY(I)
      CONTINUE
      SUM2=
      DO       I=1,M
      SUM2=SUM  +YC(I)
      CONTINUE
      CCR=SQRT(SUM1/SUM2)
      F1=K  CCR**2
      F2=L*(    -CCR**2.0)
      F=F1/F2
      WRITE  (  ,   )CCR,L,K,F,(  (I),I=  ,L)
      WRITE  (  ,   )
      WRITE  (  ,   )(TITLE(I),I=  ,  )
      WRITE  (  ,  9)
      WRITE  (  ,   )
      WRITE  (  ,  4)
      WRITE  (  ,   )
      WRITE  (  ,   )
      WRITE  (  ,   )
      WRITE  (  ,   )
      III=   9  -IBAS-M
      DO     I=  ,III
      IBAS  =IBAS+M+I-
      J=M+
        (I)=YCAL(J)
        (I)=GROWR(J)
      D(I)=UTZ(J)
      WRITE  (  ,   )IBASE,YCAL(J),UTZ(J),GROWR(J)
      CONTINUE
      CALL  AVGSD(  ,III,AVG2,SD2)
      CALL  AVGSD(  ,III,AVGR  ,S  )
      CALL  AVGSD(D,III,AVG1,S  )
      WRITE  (  ,  07)
      WRITE  (  ,  07)  VGR  ,  VG  ,  V
      WRITE  (  ,   )
      WRITE  (  ,  08)SD  ,SD1,SD2
      WRITE  (  ,   )
      L=L-
      READ(  ,  21)IPNTR
      IF(IPNTR)98,98,99
 98   IF(L)99,  ,
 99   WRITE  (  ,   )
      WRITE  (  ,   )
      WRITE  (  ,   )
      WRITE  (  ,   )
      WRITE  (  ,   )
      DO     I=  ,
      GR  (I+1)=(ACD(I+1)-  CD(I))/  CD(I)
      GR  (I+1)=(ACL(I+1)-  CL(I))/  CL(I)
 03   CONTINUE
      DO     I=  ,2
      GR3(I+1)=(CCL  (I+1)-CCL  (I))/CCL  (I)
      GR  (I+1)=(CCUD(I+1)-CCUD(I))/CCU  (I)
 09   CONTINUE
      WRITE  (  ,  19)IIX(I),  CD(  ),  L(  ),ACL(I),GR2(I),I=  ,1
      WRITE  (  ,   )(IIX(I),ACD(I),GR  (I),
      WRITE  (  ,   )
      WRITE  (  ,   )
      WRITE  (  ,  7)
      WRITE  (  ,   )
      WRITE  (  ,   )
      WRITE  (  ,  9)IIX(  ),  CLA(2),  CUD(  ),  UD(I),GR  (I),I=2,
      WRITE  (  ,  2 )(IIX(I),CCL  (I),GR3(I),
      WRITE  (  ,   )
      WRITE  (  ,   )
      WRITE  (  ,   )
      WRITE  (  ,  5)
```

```
      FORM T(//,5X,'THE CORR ...
      FORM T(//,5X,'THE ... VALUES ***')
      FORM T(...X,'** PREDICTED AVAILABILITY AND UTILIZATION'/ X,
      FORMAT(1H1////)
      FORM T(... X,26('-')/ X'TOTAL AVAILABILITY ... X,'UTILIZATION'
     *('-')//)
      FORM T( X'-----' X' AVAILABILITY' X'GROWTH RATE' X,'-----'/)
      FORM T( 2X'YEAR' X'...' ... 9X,'...'//)
     1 X,'GROWTH RATE')
      FORM T(/ 2X,I4,' X,F12.4, X,F ..., X,F ..., X,F ...)
      FORM T( 2X,I4,' X,F12.4, ... RIX'/ X,
      FORM T( (2X,F .4)///)
      FORM T( ... 0X'------------------------'/ 0X'CORRELATION MATRIX'
      FORM T( ///)
      FORM T(('-')/////)
      END
FEATURES SUPPORTED
 ONE WORD INTEGERS
 IOCS
CORE REQUIREMENTS FOR        PROGRAM
 COMMON     0  VARIABLES
END OF COMPILATION
```

APPENDIX V

LISTING PROGRAMME : OPTIMUM TRANSPORTATION

```
// JOB
// EXEC
// DD
```

```
C·
      IF(M
      IF(M
      IF(M
      IF(M
      NZ(I,J)=
      M
      M
      GO
      M
      M
      M
      M
C---SUBROUTINE
      DO
      IF(M
      GO
      DO
      IF(M
      CONTINUE
      K=
      GO
C---START
C---INITIALIZE
      DO
      L(I)=M
      MC(I)=
C---CLEAR
      DO
      J=
      MM(J)=
      MR(J)=
      K=
C---COLUMN
      DO
      IF(L(I))
      DO
      IF(NZ(I,J))
      IF(MM(J))
      NR(J)=I
      MM(J)=L(I)
      K=MR(J)
C---TEST
      IF(MR(J))
      CONTINUE
C---TEST
      IF(K)
C---ROW
      DO
      IF(MM(J))
      DO
      IF(NZ(I,J))
      IF(L(I))
      IF(NZ(I,J)-MM(J))
      L(I)=NZ(I,J)
      DO
      L(I)=MM(J)
      MC(I)=J
      CONTINUE
      CONTINUE
      GO
C---NOW
C---SCAN
C---+MMW)
      DO
      IF(L(I))
      DO
      IF(NR(J))
      IF(K)
      IF(MC(I,J)+MW(I)+MMW(J)
      K=MC(I,J)+MW(I)+MMW(J)
      CONTINUE
      CONTINUE
C---PUT
      DO
      IF(L(I))
      DO
      IF(NR(J))
      IF(MC(I,J)
      NZ(I,J)=
      CONTINUE
C---SUBTRACT
      DO
      DO
C---REMOV
      DO
      IF(MM(J))
      DO
      IF(L(I))
```

```
      MM(J)=
      NNA(J)=Z+VVA(J)
      IF(N(J).VA(J)) ,  ,
      V=V+(J)
      K=VA(J)
      N(J)=V*(J)+K
      IF(MZ(I,J))  ,  ,
      MZ(I,J)=
      MZ(I,J)=MZ(I,J)+K
      IF(V CL(J))  ,  ,
      J=V  (J)
      MZ(I,J)=MZ(I,J)+K
      IF(MZ(I,J))  ,  ,
      MZ(I,J)=
      K=NS(J)
      M (I)=M (I)+K
      K=
      DO  I= ,M
      K=MA(I)+K
      SIP(K)
      I I PRINT SOLUTION
      K=
      DO  I= ,M
      DO  J= ,N
      IF(MZ(I,J))  ,  ,
      COMPUTE TOTAL  UNIT COST OF SHIPPING SURPLUS I TO SHORT J
      K=MZ(I,J)*MC(I,J)+K
      MZ(I,J)=
      CONTINU
      DO  I= ,M
      MZSUM=0
      DO  J= ,N
      MZSUM=MZ(I,J)+MZSUM
      IF(MMP(I)-MZSUM)120,  ,130
      CONTINU
      WRITE(  ,21)
   21 FORMAT(//2X,'SUM OF QUANTITIES SHIPPED IS INCORRECT'//)
      GO TO
      DO  J= ,N
      MZSUM=0
      DO  I= ,M
      MZSUM=MZ(I,J)+MZSUM
      IF(MMP(J)-MZSUM)120,  ,130
      CONTINU
      WRITE(  ,22)
   22 FORMAT(//2X,'C',3X,'TRANSPORTATION PROBLEM OPTIMAL SOLUTION'///)
      WRITE(  ,23)
   23 FORMAT(2X,'MATRIX OF SHIPPING QUANTITIES'//)
      WRITE(  ,24)(I,I=  )
   24 FORMAT(  ,'DESTINATION'//  X,  I  )
      WRITE(  ,25)(MZ(  ,J),J=  )
   25 FORMAT(  ,'SOURCES  ',  I  )
      DO  I=2,M
      WRITE(  ,26)I,(MZ(I,J),J=  )
   26 FORMAT(  ,I2,  I  )
      WRITE(  ,27)
   27 FORMAT(2X,I2,'COST OF SHIPPING SURPLUSES TO SHORTAGES
      GO TO
      CONTINUE
      CALL EXIT
      END
```

UNREFERENCED STATEMENTS

FEATURES SUPPORTED

ARE REQUIREMENTS FOR

COMMON

END OF COMPILATION:

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Alexander Ralph S., and the Committee on Definitions, "Marketing Definitions", American Marketing Association, Chicago, 1961.

2. Alkali Manufacturers Association of India, Annual Reports, Bombay.

3. "Atmospheric Emissions from Chlor-Alkali Manufacturers", United States Environment Protection Agency, Research Triangle Park, North Carolina, 1971.

4. Balakrishna S., Techniques of Demand Forecasting for Industrial Products, Sunder Publishers, New Delhi, 1967.

5. Bell Martin, L, & Emery, C. W., "The Faltering Marketing Concept", Journal of Marketing, October, 1971.

6. Butler William, F., Kavesh Robert, A., & Platt Robert, B., Ed. Methods and Techniques of Business Forecasting, Prentice Hall Inc., New Jersy, 1974.

7. Britt, S. Henderson, & Boyd, Harper W., Jr., Marketing Management And Administrative Action, McGraw Hill Book Company, London, 1968.

8. "Caustic-soda Demand Fully Met", Alkali Manufacturers Association Report, Chemical Weekly, September, 13, 1977.

9. Chisholm Roger, K., & Gilbert R. Whitaker, Jr., Forecasting Methods. Richard D. Irwin, Inc., Ill., 1971.

10. Chemical Weekly :
Vol. XXII, September 13, 1977
Vol. XXV, January 1, 1980, &
Vol. XXVI, March 10, 1980
October 6, 1981
November 10, 1981.

11. Chirst, Carl F., Econometric Models And Methods, John Wiley & Sons, Inc., New York, 1966.

12. "Chlor-Alkali Technology", Chemical Age of India Vol. 31, No. 1, January, 1980.

13. "Chlorine Poised to Emerge As Main Product Soon", The Economic Times Research Bureau, The Economic Times, January 20, 1980.

14. Condiff Edward, W., Still Richard, R., & Govoni Norman, A. P., Fundamentals of Modern Marketing, Prentice Hall of India Ltd., New Delhi, 1974.

15. Croxton, F. E., & Cowden, D. J., Practical Business Statistics', 3rd Ed., Prentice Hall Inc., Englewood Cliffs, New Jersy, 1960.

16. Dagli, Vadulat, A Profile of Indian Industry, Vora & Co. Publishers Pvt. Ltd., Bombay, 1970.

17. Dodge, Robert H., Industrial Marketing, McGraw Hill Book Company, New York, 1970.

18. Dravid, S. K., Development of Salt Industry in India, Upma Prakashan, Jaipur, 1972.

19. Drucker Peter, F., The Practice of Management, Harper & Row Publishers, New York, 1954.

20. -----, Management Tasks, Responsibilities & Practices, Harper & Row Publishers, New York, 1973.

21. Dryden, Charles, "Chlorine Utilization Patterns in the United States", Proceedings : Seminar on Chlorine Utilization, Madras University, 1965.

22. Elion Samuel, Watson Grandy, C. T. D., Christofides Nicos, Distribution Management : Mathematical Modeling & Practical Analysis, Giffin, London, 1970.

23. Fieldman Laurence, P., "Societal Adaptation : A New Challange for Marketing", Journal of Marketing, July, 1971.

24. Fish George, "Criteria for a Theory of Responsible Consumption", Journal of Marketing, April, 1973.

25. Five Year Plans, Planning Commission, Government of India, New Delhi :

First Five Year Plan	1951-1956
Second Five Year Plan	1956-1961
Third Five Year Plan	1961-1966
Annual Plan	1966-1967
Annual Plan	1967-1968
Annual Plan	1968-1969
Fourth Five Year Plan	1969-1974
Fifth Five Year Plan	1974-1979
Sixth Five Year Plan (Draft)	1980-1985

26. "Focus on Chlorine - Scope for Gainful Use", The Economic Times Research Bureau, The Economic Times, March 5, 1980.

27. Gilbert Churchill, A., Marketing Research Methodological Foundations, Dryden Press, Ill:., 1976.

28. Hughes, David G., Demand Analysis for Marketing Decisions, Richard D. Irwin, Inc., Ill:., 1973.

29. Hausmann, E., & Karmer, E., "Survey of Different Utilization of Chlorine", Proceedings : Seminar on Chlorine Utilization, Madras University, 1965.

39. India - Handbook of Commercial Information, Department of Commercial Intelligence, Government of India, Calcutta, 1963.

31. Jhonston, J., Econometric Methods, IInd Ed., McGraw Hill Book Company, New York, 1972.

32. Kent, James A., Handbook of Industrial Chemistry, Van Nostrand Reinhold Co., New York, 1974.

33. Kharbanda, O. P., Chemoprofiles : India, Sevak Publications, Bombay, 1979.

34. Knowlton Keith, "Marketing Speciality Chemicals", Chemistry & Industry, May, 1974.

35. Kotharis, Economic And Industrial Guide of India, Madras, 1978-79.

36. Kotler, Phillip, Marketing Management - Analysis, Planning & Control, 3rd Ed., Prentice Hall of India Ltd., 1976.

37. Marketing Staff of the Ohio State University, "A Statement of Marketing Philosophies", Journal of Marketing, January, 1965.

38. Mc Cammon, Bert C., Jr., Perspectives for Distribution Programming in Vertical Marketing System, Glenview, Ill:., Scot, Foresman, 1970.

39. Methods For The Detection of Toxic Gases In Industry - Chlorine, Department of Scientific & Industrial Research, London, 1955.

40. Mikay Edward, "The Marketing Mystique", American Marketing Association, New York, 1972.

41. Moorthy, B. M. L., "Chlorine Industry in India", Proceedings : Seminar on Chlorine Utilization, Madras University, 1965.

42. Nagrajan, R., Venkateshwarlue, D., & Rao, C. S., "A General Survey on the Utilization of Chlorine in Chemical Industry Including the Recent Trends", Proceedings : Seminar on Chlorine Utilization, Madras University, 1965.

43. Porter, M. R., "The Role of Marketing Research in Chemical Marketing", Chemistry & Industry, May, 1974.

44. Ramani, R. V., "Chlor-Alkali Industry in India", Decennary Commemorative Vol. I, Electrochemical Industries In India, C. S. I. R., New Delhi, 1965-74.

45. Robinson Colin, Business Forecasting : An Economic Approach, Pitman Press Bath, Great Britain, 1971.

46. Rosenbloom Bert., Marketing Channels : A Management View, Hinsdale, Ill:., Dryden Press, 1978.

47. Rothe James, T., & Benson Lissa, "Intelligent Consumption : An Attractivo Alternative to the Marketing Concept", M S U Business Topics, (Winter), 1974.

48. Sampath, S., "Some Aspects of Utilization of Chlorine", Proceedings : Seminar on Chlorine Utilization, Madras University, 1965.

49. Sandens, H. J., & Prescott, R. F., Modern Chemical Process : Vol. VI, Reinhold Publishing Corporation, 1961.

50. Sanctioned Capacity for Non-Engineering Industries, National Council of Applied Economics Research, New Delhi, 1973.

51. Schoner, Bertram, & Uhl, Kenneth P., Marketing Research - Information Systems & Decision Making, John Wiley & Sons, Inc., New York, 1975.

52. Scone, J. D.,Chlorine, Its Manufacture, Properties & Uses, Reinhold Publishing Corporation, New York, 1968.

53. Seshion, P. K., "Development of Chlorine Products And Chlorine Utilization In India", Proceedings : Seminar on Chlorine Utilization, Madras University, 1965.

54. Shreve Norris, R., & Brink, Joseph A., Jr., Chemical Process Industries, Vth Ed., McGraw Hill Kogakusha Ltd., Tokyo, 1977.

55. Srichand Saheitya, "Caustic-Soda Output Lower", The Economic Times Research Bureau, The Economic Times, March 4, 1981.

56. Stern, Air Pollutants - Their Transformation & Transport, Dryden Press, Ill:., 1978.

57. Stock Exchange Directory, Bombay, 1980.

58. Tarling, E. Nichell., "Marketing Heavy Chemicals", Chemistry & Industry, December, 1974.

59. "The Human Concept : New Philosophy for Business", Business Horizons, December, 1969.

60. Webster, Fredrick E. Jr., "Role of Industrial Distributor", Journal of Marketing, July, 1976.

61. Wiseman Peter, An Introduction to Industrial Organic Chemistry, Allied Science Publishers, London, 1971.

62. Wolfe, Harry Deane, Business Forecasting Methods, Holt Rinehart & William Inc., New York, 1966.

63. "World Chlorine Production Will Rise At A Steady Pace", Chemische Industrie International, Chemical Weekly, September 13, 1977.