



## CHAPTER XXIII

# CHEMICAL ENGINEERING AND INDUSTRY

### CHEMICAL ENGINEERING VS OTHER ENGINEERING DISCIPLINES

Chemical engineering had a unique start, in contrast to the other engineering disciplines, in that right from the beginning it was a degree course. In other branches of engineering we had old institutions like Howrah College of Engineering, Kolkata; Guindy College of Engineering, Chennai; Poona College of Engineering, Pune; V.J.T.I., Mumbai; and Thomason College of Engineering (now University of Roorkee), Roorkee; which started with diploma courses and introduced degree courses later. The even more attractive feature was that universities took a lead and started courses in Chemical Engineering and Chemical Technology. These were essentially post B.Sc. Courses. In the early 1950's these courses became 4-year post Inter Science (subsequently Senior Secondary) courses. Since Chemical Engineering and Chemical Technology were taught by University Departments, research became important as these departments were measured with the same rigour as other sciences and liberal arts. Thus the PhD programmes were introduced quite early. Jadhavpur University (earlier called National College), Kolkata; Panjab University, Chandigarh; Andhra University, Vishakhapatnam; Banaras Hindu University (BHU), Varanasi; Calcutta University, Kolkata; Indian Institute of Science, Bangalore; University Department of Chemical Technology (UDCT), Mumbai took an early lead. Later A.C. College of Technology, Chennai; L.I.T.

Nagpur; Annamalai University, Annamalai etc. came into existence. The UDCT was unique as it was planned by industrialists and philanthropists, with substantial financial support - consequently it was the first department to get autonomy under the provisions of the University Grants Commission and University of Bombay, Mumbai. Prior to the partition, Panjab University, Lahore, offered courses in chemical technology. Jadavpur has the distinction of conceiving and executing the first course in Chemical Engineering. BHU was a pioneer in courses in Chemical Technology. Prominent personalities that belonged to the period 1930-50 were S.C. Venkat Rao, G.P. Kane, P.S. Mene, Govind Rao, N.R. Kamath, G.S. Laddha and M.N. Rao.

A major event was the establishment in early 1950's of a series of Indian Institute of Technology (IIT) now six in all initially with the help of the then USSR, UK, USA, Germany. All these institutions opened chemical engineering courses and ushered in a major change, nationally and internationally.

### CHEMICAL INDUSTRY IN INDIA

Prior to 1947, India had hardly any chemical industry-the small explosives factory (at Kirkee, near Pune and Arvankandu, Nilgiris) and small single superphosphate plants, with attached sulphuric acid plants were small units with limited production. Bengal Chemicals in Kolkata was a pioneering group and had a nationalist academic entrepreneur Acharya Prafulla Chandra Ray (see Chapter on Torch-bearers)

as the key person in all respects. India's sugarcane industry needed phosphorus as a part of the fertilizer and this was supplied as single superphosphate. Sindri fertilizer plant was a second world war reparation gift and was based on coal from nearby fields and gypsum (which after partition had to be hauled all the way from places near Jodhpur in Rajasthan). There was no petroleum refining except for a tiny unit, processing 0.25 mtpa, in Digboi, Assam, based on local crude oil and to service the thriving tea gardens. The first three refineries (two in Mumbai and one in Vishakhapatnam) came up in early to mid 1950's and made a quantum change in the Indian scenario. The first planned fertilizer plant was of Fertilizer Corporation of India in Mumbai, adjacent to the refineries (now called RCF). The Nangal plant was really planned to utilize surplus cheap power from Nangal so that electrolytic hydrogen for ammonia became viable. Since there was no CO<sub>2</sub>, ammonium nitrate (AN) and calcium ammonium nitrate became the chosen fertilizers. Ammonium nitrate could also be used as an explosive. Alas the surplus power became an illusion in early years of operation and technology change had to be brought in. The Nangal plant was also the first to start production of Heavy Water, required for nuclear energy programme.

Sugar industry provided cheap molasses and with the prevalent prohibition, ethyl alcohol became an attractive raw material. Late 50's and early 60's saw the emergence of the organic chemical industry in India but soon thereafter there was a serious deficit of ethanol. Nagaraja Rao and G.P. Kane played a key role in promoting the alcohol-based industries. However, surplus naphtha from refineries became a convenient raw material but even this became short in mid 1970's and became surplus again in 1990's. The discovery of the natural gas and crude oil in Assam, Gujarat and Bombay High brought a major change and a long Natural Gas pipeline called HBJ pipeline of about 1800 km length, from Bombay High to Jagdishpur in UP was established in 1980's. Later Natural Gas was discovered in Godavari coast also.

## TEXTILE INDUSTRY

India has enjoyed a high reputation in cotton textiles. Initially we thrived on spinning and weaving. After Independence, processed fabrics became important in India and the UDCT, Mumbai, played a pivotal role in this endeavour. The thriving textile industry needed chemicals like caustic soda, bleach liquor, dyes, pigments and a number of prominent textile houses, like Delhi Cloth Mill, Mafatlals, Sarabhai started chemical units to manufacture caustic soda, chlorine, dyes.

The need for rayon industry was felt in 1940's and NRC, Kalyan (near Mumbai), Century Rayon (Shahad, near Mumbai) came into existence where sulphuric acid, rayon grade caustic soda, were required and captive plants were established.

## SODA ASH

Mithapur, near Okha port, Gujarat, saw the birth of the first major salt based industry and became an important Solvay plant in the global context. This unit was pioneered by Kapil Ram Vakil and later taken over by Tata Chemicals, where the truly outstanding chemical engineer Darbari Seth made monumental contributions.

## RESEARCH LABORATORIES

Government of India took a major decision, just before Independence, to establish the Council of Scientific & Industrial Research (CSIR) and in chemical sector the pioneering laboratory was the National Chemical Laboratory (NCL), Pune, established in 1950. Prior to this the Nizam State, Hyderabad, had a Central Laboratory, later called Regional Research Laboratory (RRL), Hyderabad, by the CSIR, (presently called the Indian Institute of Chemical Technology). Many RRL's were subsequently established. From the chemical industries point of view the additional CSIR laboratories of significance were the Indian Institute of Petroleum, Dehra Dun; Central Salt and Marine Chemicals Research Institute, Bhavnagar; Central Electrochemical Research Institute, Karaikudi and

Central Leather Research Institute, Chennai. For drugs we have Central Drug Research Institute, Lucknow and Institute of Microbial Technology, Chandigarh. Much earlier we had, in the coal belt, the Central Fuel Research Institute, Dhanbad.

The above laboratories had many outstanding chemical engineers, chemical technologists and chemists. A specific mention must be made of K. Venkataraman (UDCT and NCL), B.D. Tilak (UDCT and NCL), both were contributors to the birth of the dyestuff industry in India. A distinguished galaxy of chemical engineers further enhanced our capabilities in diverse fields. This included some of our late Fellows: Y.Nayudamma, S.C.Bhattacharya, G.S.Sidhu, Hussain Zaheer and number of still active scientists.

### RESEARCH IN NUCLEAR SCIENCES AND NUCLEAR POWER

The establishment of Atomic Research Centre, Mumbai, now called Bhabha Atomic Research Centre (BARC), to honour the founder of nuclear research in India, Homi Bhabha, and other laboratories made a major impact for chemists and chemical engineers. This got buttressed with the establishment of Nuclear Power Plants, with the associated units for nuclear fuel and Heavy Water. Chemical engineers played a vital role in the above area as well as in the exploration of rare earths. (See write-up of DAE).

### DEFENCE & SPACE RESEARCH ESTABLISHMENTS

The Defence Research and Development Organization (DRDO) requires a large number of chemical engineers, chemical technologists and chemists. Space research, particularly for rockets, required chemical engineers. Contributions to polymers and chemicals used in the space programme constitute vital inputs for the success of this endeavour.

### ACADEMIC RESEARCH

As chemical engineering started in University Departments, research became an integral part of the activities from inception and a special mention

should be made of the UDCT, Mumbai (which continues to occupy a prominent position) and the Indian Institute of Science, Bangalore. In later years IIT's became important centers.

The scientific contributions of Indian Chemical Engineers has been widely acclaimed both nationally and internationally. Among many such recognitions and awards mention may be made of Fellowship of the Royal Society, London to two of them.

### DESIGN AND FABRICATION CAPABILITIES

In earlier years FACT, Kochi, and the Sindhri unit of FCI had some design capabilities. The creation of Engineers India Ltd (EIL) brought out a quantum change in India, particularly for petroleum refining and petrochemicals. EIL also carried out work overseas. A number of multinational companies and some Indian companies later entered into this business. Thus detailed engineering became world class.

International class mechanical design and fabrication facilities at Larsen & Toubro, Mumbai and BHPV, Vishakhapatnam, further strengthened the Indian position in putting up plants involving very high pressures and complicated designs.

### ESTABLISHMENT OF INDIAN INSTITUTE OF CHEMICAL ENGINEERS

As in the case of the USA and UK, the Indian chemical engineers also thought it prudent to have a separate professional group of their own and this was realized in 1947 through sustained efforts of H.L. Roy in Jadavpur, Kolkata. A number of illustrious persons have been Presidents and these included R.R. Hattiangadi, who made major contributions in the cement industry from early 40's, G.P. Kane, G.S. Laddha, who did world class research in liquid-liquid extraction at A.C. College, Chennai, G.S. Kasbekar, who headed the first public sector integrated organic chemicals complex, Hindustan Organic Chemicals, Rasayani.

## INDUSTRIAL R&D

In the late 1950's, companies such as the National Rayon Corporation had design and development departments and executed some of their projects on their own. A similar situation existed in Delhi Cloth Mills. A number of technocrat entrepreneurs entered the Indian scene from 1960's onwards. The earliest case of world-class processes came from a qualified chemical engineer K.H. Gharda, Gharda Chemicals, where the first blue phthalcyamine dye was made, which was superior to the best available in the world. This was followed by several breakthroughs in speciality chemicals and more specifically agrochemicals. For a well-known herbicide, Isoproturon, a non-phosgene process was developed, even before the Bhopal disaster. This was the first such process globally. Many technocrat entrepreneurs have made the Indian scene vibrant.

The Indian Petrochemicals Corporation Ltd, (IPCL), had the unique distinction of having a Director, R&D, on Board of Directors, even before the commercial production commenced. Subsequently India's largest oil refining company, Indian Oil Corporation, Ltd. had created a place for R&D Director on the board. Shri Lov Raj Kumar deserves credit for spearheading these momentous changes. Hindustan Lever was the one of the earliest to have an R&D Centre and an R&D Director on Board. Ciba Research Center was established in Mumbai under Govindachari as the chief and made many valuable contributions. Alas, this unit was later folded up and the same fate was met by the Hoechst Research Centre in Mumbai.

## ADVENT OF RELIANCE INDUSTRIES- A PHENOMENON

The Reliance group of Industries, changed the fundamentals of business in the chemical industry. To start with polyester filament plants were established with a daily capacity equal to the annual capacity of some pioneering companies. In the case of polyesters they have a unique global position of complete integration from basic raw materials *p-xylene*, terephthalic acid, ethylene, ethylene glycol, to finished fabrics and also resins.

The world's largest *p-xylene* plant, at Jamnagar and the world's largest greenfield petroleum refining company have been established in Jamnagar by the Reliance Industry, in record time and with lowest per unit capital investment. Indian chemical engineers have played a pivotal role in this gigantic exercise.

The chemical industry is the first science based industry and the first one to become global. More than 300 mtpa of some more than 1,00,000 chemicals are produced with a turnover of USD1.6 trillion. No industry has made as much impact on the quality of life as the chemical industry.

## CONCLUDING REMARKS

Chemical engineering has contributed immensely to continuous processes, process integration and intensification, safe operations, astute scale-up. Chemical engineering is exciting, rewarding, challenging and edifying (and even entertaining!).

