Fifty years of chemical engineering profession in Bangladesh

DR IQBAL MAHMUD

CHEMICAL Engineering as a distinct engineering discipline is now more than hundred years old. The first century of growth of Chemical Engineering has been synonymous with the phenomenal growth in industrialization throughout the world. Demand for new products, increased efficiency, better resource utilization, high purity outputs and, more recently, the emerging world of biotechnology have provided this discipline new challenges which have been met adequately.

Birth of a new engineering discipline

Early 20th century saw the growth of petroleum refining industries that, to start with, involved several physical separation processes. This was followed by several downstream industries incorporating chemical reactions like cracking, hydrogenation, chlorination, nitration, etc. With the rapid diversification of chemical and process industries it became obvious to both industry and the academic world that it was no longer possible to serve the sector purposefully with the help of industrial chemists specialized only in single industries.

On both sides of the Atlantic designs for the first curricula of the new discipline of Chemical Engineering emerged. Arthur D. Little in 1915 proposed to MIT the concept of "unit operations", the idea that an operation such as distillation, gas absorption, filtration etc. could be applied to a number of different materials of different characteristics in different chemical and process industries. Consequently, it was no longer essential to specialize in operation of individual manufacturing processes as the industrial chemists were used to. Chemical Engineers began to be treated to a unique curricula which provided tools to adapt themselves quickly to the ever changing world of chemical and process industry.

Beginnings in Bangladesh

The founding fathers of engineering education in the then East Pakistan took a forward looking decision in establishing the "Department of Chemical Engineering" in 1948 in the erstwhile Ahsanullah Engineering College. This was done in the fond hope that graduates form the department would play a pivotal role in industrializing the newly independent country. This was indeed a hold step considering the fact that the profession was yet to have wide acceptance outside the Anglo-American sphere of influence. Even in Europe independent departments of Chemical Engineering were not yet popular. In this respect the academic initiative and intellectual courage demonstrated by Prof. M.A. Naser, Late Prof. A.Q. Chowdhury, Prof. Syed M. Mazharul Huque and others are indeed praiseworthy. However, while the academics were ready to produce graduates in this new and promising profession, industry was yet to appreciate the role of a Chemical Engineer. The first batch of Chemical Engineers graduated in 1952 and during the initial years only a few graduates were produced.

The mid fifties of the 20th century was a time when natural gas-based industries (e.g. Urea) and paper industries were either being planned or implemented in the country. The ChE faculty at AEC took pains to impress upon the then industrial leaders the need to utilize the members of the new profession. However, the senior technical leaders of industry (largely in public sector), with training and experience in the older mode of running chemical and process plants with chemists and mechanical engineers, were hesitant or reluctant to take the "risk" of employing engineers about whose training and purpose they were only vaguely familiar. This author, after graduating from the department in 1960 applied for the position of an Assistant Chemical Engineer in a sugar mill. He was asked to appear at an interview for the post of an Assistant Chemist. When he tried to explain the role of a Chemical Engineer to the interview board he was finally offered the position of an Assistant Mechanical Engineer! This personal anecdote typically demonstrates the "confusion" that reigned during the early days of this profession in this country.

Chemical and process industries in Bangladesh

In the industrialization of Bangladesh, the first choices with respect to technology were comparatively easy. Industries that could help the growth of agriculture, agro-based industries, e.g. jute and traditional production units for import substitution such as textile and sugar, got preference for obvious reasons. Their technologies were not complicated. For instance, textile, jute, and sugar technologies are relatively simple and repetitive and one only needs more machines, more capital formation. These are also largely final-consumer-goods industries. But succeeding choices have been difficult and required considerable background studies and search, and properly qualified technological manpower.

At the time of partition, there were only five sugar mills and one cement plant. In the early fifties, the then Pakistan Industrial Development Corporation set up the paper mill at Chandraghona based on bamboo and it went into commercial production in 1953. With this paper mill came a number of chemical plants on the same site including sulfuric acid, lime, alum, sodium hydroxide, chlorine etc. Some of the milestones of the development of major chemical process industries in Bangladesh are installation of an integrated pulp and paper mill in Chandraghona (KPM) in 1953, first Urea- factory in Fenchuganj in 1961 and the first petroleum refinery in 1967.

The initial thrust for development of chemical and process industries was provided by large corporations in the public sector. The private sector was involved only in small/medium industries like Soap, Detergents, Cosmetics, Pharmaceuticals etc. However, since the decade of the eighties there has been a gradual shift in emphasis and the sate owned enterprises are being disinvested and the private sector is being encouraged to participate in almost all sectors/sub sectors of industry. Indeed, recent trends show that within the chemical/process sub sector, the private sector has shown considerable interest in setting up several industries viz., Cement, Ceramics, Pulp and Paper, Pharmaceuticals, Agro and Food Processing, etc. However, KAFCO remains the sole instance of private sector involvement in a large chemical process industry.

The contribution of the manufacturing sector to GDP has crossed the double figures recently. In terms of their share in manufacturing GDP, the Chemical and Pharmaceutical sub sector contributes nearly 20%. This does not include the contribution of natural gas based industries like fertilizer or imported crude based refinery. In view of the government control of output prices the value added figures for petroleum and fertilizer industries are very low according to Bangladesh Bureau of Statistics. It is felt that their true contribution to manufacturing GDP is not fully represented in such economic measures. One needs to measure the **"technology content added"** along with "value added" in order to truly measure the contribution of complex units like modern chemical process industries. Given these distortions, the contribution of chemical process industries is perhaps not truly reflected in statistics.

Early constraints in the development of the profession

After Bangladesh became independent, she already had two urea fertilizer factories and was planning for the third. Which meant technical personnel with more than ten years plant experience were available in the country. However, at that point of time donors while assessing the in house technological capability remained unimpressed and suggested that for the planned Ashuganj urea plant a large number of expatriates should be put in place at each and every stage of planning, implementation and operation. The World Bank in its appraisal reports commented, "There are major risks involved in the projects. To build a complex fertilizer plant in a country of Bangladesh's state is in itself a formidable undertaking".... "No country, but least of Bangladesh's general state of poverty and limited resources, can afford inefficient project implementation and the introduction of expatriate expertise in project management as well as production functions in addition to the Engineering Firm and the Technical Adviser and their clearly delineated responsibilities as well as their smooth cooperation with the Bangladesh staff is a *sine qua non* for a successful project."

Due to lack of vision of the industry leaders, the donors took the upper hand. Thus, we cannot avoid the blame of not having taken any initiative in institutionalizing local technological capability in respect of technology assessment and design engineering. No initiative had been taken during 60's to develop engineering design and development capacity in this particular field. Mere experience in the successful operation of complex chemical plants do not constitute technology transfer in the real sense of the term. Granting that it takes longer gestation period to develop the hardware part of such technologies in a developing country, it should have been possible by then to have 'in house' capability in the various software aspects, viz., identification of various components of the technological packages to be imported, checking of the process design information, tender evaluation of vendors' offers and installation of the various components of the plant.

Lack of initiative from industry leaders and decision makers, invisible wall of resistance from vested quarters and professional rivals often created road blocks in the development of the profession during the early years. However, during the design stage of CUFL an offer was made form UNDP/UNIDO for assistance in setting up of a full fledged Engineering Design Division in BCIC. However, the project got lost in the bureaucratic maze in the Ministry. Here was an opportunity for Chemical Engineers to professionally contribute in an area for which they are specially trained. Sadly, yet another opportunity was lost. KAFCO, which is the only large chemical process plant in the private sector, has been able to reach production targets 15-20% above the nameplate capacity in recent months due to introduction of process changes that were initiated, planned and implemented by local engineers. Being in the private sector, the Chemical Engineers in the plant (along with other relevant professionals) are now able to initiate investment decisions that are not subject to scrutiny by layers of bureaucracy as in case of such units in the public sector.

In the private sector Chemical Engineers have demonstrated that they can be innovative in developing Ceramic and medium scale Basic Chemical industries. Obviously the flexibility and entrepreneurial ambience in those sectors helped them to put into practice their ideas and innate capabilities.

Capacity building

Accumulating technological capacity through technology transfer efforts is one of the avowed objectives of any development process. However, during the early years of industrialization in the country it was often not appreciated that mere transfer of hardware and services for installation and start up of an enterprise does not constitute any transfer of technology at all. In Bangladesh, especially during the early years of industrialization efforts, installation of a manufacturing unit has often been equated with technology transfer. This is obviously wrong. Transfer of mere hardware does not constitute technology transfer. The ideal would be **"DYNAMIC"** transfer where one obtains the knowledge, skills and experience to manipulate and change the production system and gains the capacity to innovate. Such a transfer constitute the real addition to a nation's technological capacity.

In spite of the constraints and unnecessary road blocks in the way of their natural professional development, Chemical Engineers have made their presence felt in several areas of technology absorption and adaptation processes in the country. In the following table the author has attempted to present his personal estimate of the degree of professional capability gained by Chemical Engineers till to date.

Concluding remarks and looking ahead

* It is now well understood in most developing countries that while industrial units can be set up through foreign aid in its various forms, technology is a commodity which has a price tag attached to it. There is no "fixed price" for technology. The price depends on the bargaining capacity of the recipient country. The bargaining capacity is derived from the capability for judicious selection, knowledge of world technology shelf, in-house engineering capability and adequate academic background of the recipient. The profession of Chemical Engineering is poised to play a key role in augmenting this bargaining capacity.

* The corporations in the public sector do have Chemical Engineers with long experience in relevant enterprises. Lately, these experts have been involved in evaluation of technology proposals. However, institutional arrangements to assess, adapt and absorb the largely imported technology are still in a rudimentary stage. Thus, the sector in general and chemical industry in particular have not yet been infused with an innate dynamism which can propel it to reach new heights of chemical engineering innovation and creativity.

* Experience of more successful Asian countries like India, South Korea and notably Japan prove that the weakness of the existing material base does not constitute insurmountable barriers to development of chemical industries provided the human resource base and the socio-economic and cultural environment are deliberately transformed to fruitfully utilize imported technology.

* Successful absorption of imported technology in the country require institutional arrangements where Chemical Engineers can meaningfully utilize their training and skills. The development activities would include efforts to replicate existing vintages of technology utilizing knowledge accumulated from long years of operating existing plants, design engineering initiatives for adapting some of the processes to suit local raw materials and conditions and pilot plant studies on some promising locally developed processes.

Table 1
Professional Capability and Areas of Competence of Chemical Engineers

Activity	Current Level of Competence of Chemical Engineers	Other Professionals Involved
A) GENERAL CONSULTANCY		
a) Feed Stock & Process Evaluation	High	ndustrial Chemists and Engineers
b) Bid Document Preparation	High	Other Engineering Disciplines
c) Bid Evaluation	High	Other Engineering Disciplines
B) PROJECT PLANNING		
a) Project Profile	High	Economists, Other Engineering Disciplines
b) Market Research	High	Economists, Other Engineering Disciplines
c)Techno-Economic Feasibility Report	High	Economists, Other Engineering Disciplines
d) Detailed Project Report	Moderate	Economists, Other Engineering Disciplines
C) COMPLETE ENGINEERING		
a) Mechanical	Low	Mechanical Engineers
b) Electrical	Not Applicable	Electrical Engineers
c) Instrumentation	Moderate	Electrical and Mechanical Engineers
d) Civil, Structural etc.	Not applicable	Civil Engineers
D) PROJECT MANAGEMENT		
a) Procurement	High	Mechanical and Electrical Engineers
b) Fabrication	Not Applicable	Mechanical and Electrical Engineers
c) Inspection	High	Mechanical and Electrical Engineers
d) Monitoring & Scheduling	High	Mechanical and Electrical Engineers
e) Construction & Installation	High	Mechanical, Electrical and Civil Engineers
f)Commissioning	High	Mechanical, Electrical, and Civil Engineers
E) ENVIRONMENTAL CONTROL		
a) Air Pollution Control	Moderate	Environmental Scientists
b) Effluent Treatment	Moderate	Civil Engineers, Environmental Scientists

Fifty years of chemical and allied industries in Bangladesh

ENGR. RASHED MAKSUD KHAN

HISTORICALLY the development of chemical industries in the undivided Bengal started with the setting up of factories producing stynthetic dyes, bleaching, sizing chemicals, surface activate compounds and other finishing chemicals used in textile industries for processing of textile yarn and fabrics. Apart from those, the first chemical plant set up in Bengal was in 1870 for manufacture of paper. In 1892 Bengal Chemical and Pharmaceutical Works was established by one of India's renowned scientists Acharya Prafulla Chandra Ray.

Post-partition era

The then East Pakistan inherited very few industries from the British Colonial Rulers. Apart from the handful of Textile mills, Setabganj Sugar Mills was established in 1933 and Chatak Cement Factory was established at Chatak in 1941.

During the 1947-72 period i.e. during the Pakistan days industrial development took place in the private sector with the active support of the Government. The largest Jute Mills was established in Narayanganj in the year 1952 by the Adamjees which at one time used to be the pride of this country.

The Pakistan Industrial Development Corporation PIDC created in 1952 and later bifurcated as WPIDC and EPIDC in 1962 was one of the major organizations which boosted the economic activities of the country by giving support to the private sector in establishing industries in various fields.

The EPIDC during its one decade of existence (1962-1971) had established 74 manufacturing units. Out of these there were 27 chemical industries as enumerated below:

Paper Industries	4
Cement Industries	3
Fertilizer Industries	2
Chemical Industries	5
Pharmaceutical Inds.	2
Sugar Industries	11

Role of chemical engineers

With the development of the chemical industries the need for the services of the chemical engineers were realized sharply and the EPIDC became one of the major employers of chemical engineers in Bangladesh. With the development of increasing number of chemical industries, the chemical engineering education gained momentum and attracted increasing number of students. Also the curriculum and courses have been up dated and designed to meet the need of the time. Very soon, the potentials of the chemical engineers have been well recognized by the industries.

In the 1962-1971 period a few chemical industries in the private sector came up with the manufacture of cosmetics, toiletries, detergents, glycerine, etc. Prominent among those were: Kohinoor Chemical Co., Commander Soap Co. Ltd., Albert David, Pharmadesh Limited.

Simultaneously, some new industries also emerged in other sectors like Glass and Ceramics, Machine Made Bricks, etc. The following industries were quite prominent in those days: Usmania Sheet Glass Industry, Hardeo Glass Factory, Hyesons Glass Industry,Ali Glass Industry, Peoples Ceramic Industsries, Mirpur Ceramic Works,Bengal Glass Industries.

Those industries made positive contribution to the economy of the country. Besides, a good number of small size industries had been set up under the East Pakistan Small and Cottage Industries Corporation (EPSCIC) which used to produce organic and in-organic salt and compounds (intermediaries) for other industries.

Reforms in government policies and process of privatization.

In view of the recurring losses and serious sloth in the economy of the country, the government of Bangladesh in 1975 realized the need for denationalizing some of the SOEs and involving the private sector to run the industries. The Bangladesh Chemical Industries Corporation (BCIC) was formed by merging three smaller corporations dealing in chemicals, Fertilizer and Pharmaceutical. During the same period, further reforms were made and following sector corporations became effective from 1976.

Bangladesh Jute Industries Corporation

Bangladesh Textile Mills Corporation

Bangladesh Chemical Industries Corporation

Bangladesh Steel and Engineering Corporation

Bangladesh Oil Gas and Natural Resources Corporation named as Petro Bangla

Bangladesh Forest Industries Corporation

After reorganization BCIC disposed of a few sick industries and at the same time, developed new industry in the fertilizer sector. There are six Urea Fertilizer Complexes under BCIC. BCIC also established one TSP plant in Chittagong producing about 180,000 tpy: TSP Fertilizer. The first Sanitary Ware and Insulator Factory was established by the BCIC in 1975 which is running profitably. It subsequently added a tiles factory.

Private sector initiative in the chemical industries

With the changes in the investment policy and backing of the government private sector initiative was encouraged and a number of industries developed in the private sector specially for the manufacture of: Pharmaceuticals, Ceramic Tablewares, Ceramic Bricks and Tiles, Urea Fertilizer (KAFCO), Sulfuric Acid and other Chemicals, Edible Oil, Refractories, Cement, Paints and Varnishes, Battery, Specialised papers and Packaging Materials.

Thus, with the open minded policies of the government towards privatization and free market economy, a new era of development of knowledge based, technologically sound and economically viable chemical industries have opened up in Bangladesh. The success and failure of the private enterprises would depend not only on the managerial and marketing skill of the entrepreneurs but also on external forces and factors beyond control of the enterprise. To evaluate privatization, one has to consider the overall economic environment of the country.

We can avail raw materials and know-how from countries like Thailand and we may have access to their markets and also with their joint investment, we may compete in the developed countries' market.

Although the Bangladesh economy is still struggling there are some encouraging signs, enunciating from the new private sector. Apart from the traditional industries the non-traditional items produced by the chemical industries bear testimony of the high rate of the success the private sector have achieved through export of their products in the developed countries. The porcelain, stoneware and bone china products and also the floor tiles and glaze tiles are glaring examples in this respect. The ceramic sector has attained an export of nearly US$ 50.00 million and given due support, it would soon reach US$ 100 million.

Financial problems faced by the industries

Although the government has adapted strategy of export led growth by the private sector and progressively liberalized the macro-economic policies, there has not been proper reforms in the banking sector. The Nationalized Commercial Banks, over burdened with age-old debts and liabilities and inefficiencies of the management, have very little resources to service the emerging new private sector industries. On the other hand, the private banks established in the country are over cautious and would not take any risk in long term investment. Most of them would only finance trading and shall not come up for investment in manufacturing sectors.

Two Development Financial Institutions (DFIs) namely Bangladesh Shilpa Bank and Bal1gladesh Shilpa Rin Sangstha which have for long been remaining dornant neither support their existing clients nor make any new investment, despite having sufficient reserves.

Stock market

The Stock Market which is an alternative source of funds for investment are being re-organized to boost investment, and the SEC has been engaged to ensure transparency in the transactions in order to attract more investors.

Foreign direct investment

Foreign Direct Investment are essential for rapid industrial growth and also for technological development in the country. Both the government and the private sectors are working hard to avail the opportunities created due to globalisation and the free market economy.

There are enormous opportunities provided by the government in the Export Processing Zone (EPZ) established by the government. In the EPZs there is no duty on the capital machinery and the returns and profits can be repatriated freely and free from income tax. Other than in the EPZ too, the government has been encouraging FDI in large chemical and petrochemical industries, power generation, and other infrastructure schemes with similar facilities.

The investments which already took place in the EPZs from Japan, Korea, Singapore and other countries have proved to be very profitable, and they have encouraged many other investors to come forward with new investments.

However, Bangladesh being an LDC and founding member of the WTO, is obliged to a wide range of commitments in the areas of trade and investment. The country has to adopt policies to ensure:

I. WTO compatibility,

II. improvement of conditions for enhancing quality, environment and control of pollution and health hazard,

III. the rights and privileges of the working class as per ILO, and

IV. elimination of child labour

Some industries in the private sector have already attained international standard and achieved the above conditions successfully by introducing ISO-9000 and ISO-14000.

Investment prospects and opportunities

With the positive and daring moves taken by the entrepreneurs and also the progressive policies of the government. it is quite heartening to observe that there has been some worthwhile investment in the country. In the period from 1981-90 some 414 units came into existence mostly in the EPZs in the country. Between 1991 and 1994 about 2300 industrial units have been registered with the BOI having a total investment of US$ 2241 million. Out of those, 253 units were direct foreign investment at a cost of US$ 1102 million. Some of the potential sectors of investment are: 1) Energy, Oil and Gas, 2) Fertilizer and Gas based industries, 3) Leather and Leather goods industries, 4) Food and Allied industries, 5) Insecticides and Pesticides.

There are encouraging prospects for investment in a number of other allied industries having know-how from the developed countries. Both local and foreign investors would enjoy the benefits and facilities that Bangladesh as an LDC would receive from developed countries in Europe, Canada, Australia and BIMST-EC Countries.

Recommendations

To augment the growth of the chemical industries and to make the best use of our available resources and qualified manpower, the following measures must be taken:

- The tariff on industrial raw materials must be rationalized to make production competitive and profitable.

- Tariff on the use of gas as fuel, and electricity for industrial use shall be minimized and the supply must be made available removing all complexities of terms and conditions.

- Import of capital machinery and spare parts for at least 3 years must be made free of duty and taxes.

- Interest on capital loan must not exceed 2 percent above the Libor or the rate at which the Government receives the fund.

- Tax Holiday must be allowed to the industry for a minimum period of 5 years from the date of commencement of commercial operation.

- Working Capital must be provided at a rate of interest not exceeding 6%.

- Repatriation of technical know how design and engineering fees where applicable shall be allowed without any hastle.

With worldwide globalization and competition by both the developed and developing countries, we would be able to attract investment only if we are able to offer increased facilities and also ensure an enabling environment by way of establishing the rule of law and ensuring a healthy atmosphere.

Conclusion

We can avail raw materials and know-how from countries like Thailand and we may have access to their markets and also with their joint investment, we may compete in the developed countries' market. Hydro-electricity can also be generated jointly with Myanmar or with Nepal and we may avail power at a cheaper rate, and can share and exchange other industrial products with them.

Development of Dyes and Chemicals with indigenous raw materials and production of organic fertilizers would be environment friendly and free from health hazard. Those may be developed in order to attract foreign buyers.

The development of small and medium sized industries in the country in the private sector would give rise to the creation of employment and help in poverty alleviation. Besides, large chemical plants should be set up in the public sector with natural gas as the basic raw material and fuel for the production of ammonia based chemicals and chemical fertilizers which have tremendous potential.

Continuous research and evaluation of appropriate technology have to be carried out jointly by the Research Institutions, Universities and the local Industries in order to minimize pollution, reduce wastage, enhance the quality and ensure competitiveness.

The author is President, Chemical Engineers' Alumni Association

Plenary Lectures

Plenary Session 1: Monday, 29/12/03, 11:00 am; Council Bhaban
Chairman: Dr. Iqbal Mahmud
Co-chairman: Engr. Rashed Maksud Khan

1 "Growth of Ceramic Industry in Bangladesh" *Mahmudur Rahman*
2. "Membrane-based Separations: Past, Present and Future Trends" *Shamsuddin Ilias and Jian-hong Lou*
3 "The Age of Computer-Aided Product-Process Synthesis & Design" *Rafiqul Gani*

Plenary Session 2: Tuesday, 30/12/03, 9:00 am; Council Bhaban
Chairman: Dr. Nooruddin Ahmed
Co-chairman: Engr. Quamrul Islam Siddique

1. "Engineering in Medicine" *Dr. Marvin Slepian*
2. "Bottlenecks in Ethanol Production From Renewable Resources by a Metabolically Engineering Microorganism" *David B. Hodge, Alex D. Hernandez-Soto and M. Nazmul Karim*

Invited Lectures on Industry

Invited Lecture Session 1: Monday, 29/12/03, 2:00pm; Council Bhaban
Chairman: Engr. Rashed Maksud Khan
Co-chairman: Dr. M. Sirajul Islam

1. "Petroleum Sector of Bangladesh" Issues and Prospects" *A.S.M. Bashirul Huq*
2. "Pharmaceutical Industry in Bangladesh" *A. K. M. Shamsuddin*
3. "Ammonia-Urea Industry in Bangladesh" *A.K.M. A Quader*

Invited Lecture Session 2: Tuesday, 30/12/03, 11:00 am; Council Bhaban
Chairman: Engr. Syed Kamal Rabiul Haque
Co-chairman: Engr. M. Badiuzzaman
(Programme to be announced later)

Technical Sessions

Paper No — Title/Authors

Session 1:29/12/03, 3:45pm; IAT Lecture Room
Session Chairman: Dr. MS Uddin
Co-chairman: Dr. SK Das

001 Conversion of Methanol to Olefins in a Fixed Bed Reactor: Effect of Different Models *P. Gupta, A. Saha, AK Sadhukhan and RK Saha*
008 A Novel Reactor-Biofilter System for the Treatment of Hydrogen Sulfide and VOC Containing Emissions -- *L. Xiaobing, S Viswanathan and S. Farooq*
009 Thermodynamics of Ionic Liquids: A review -- *T. Banerjee, MK Singh, A. Agarwal and A. Khanna*
030 Challenges of Photocatalysis for Water Purification *MF Kabir, E Vaisman, CH Langford and A. Kantzas*
032 Catalyst Development for the Conversion of Biomass to Fuel Gas -- *M. Asadullah*
034 HDPE -- Polymerization Using Synthesized Metallocenes and Cocatalysts *S.Kumar, V. Katiyar and A. Khanna*

Session 2: 29/12/03, 3:45pm : DCE Lecture Room
Session Chairman: Dr. S. Farooq
Co-chairman: Dr. SFA Hussainy

012 A study on the Effluent of Natural Gas Fertilizer Factory Ltd. (NGFFL) and its Adverse Impacts on the local Environment *MSKA Sarkar, MT Rahman, MNA Khan, P. Datta and ASMSI Dakua*
016 Estimation of SO2 and NOx Emission from Combustion of Fossil Fuel in Bangladesh *AK Azad, MAYA Harun and J. Sultana*
017 An Economic Evaluation of Air Pollution in Dhaka City -- *AK Azad, J. Sultana and S. Jahan*
018 Vehicular Air Pollution and Its Impacts on Human Health in Khulna City *AK Azad, J. Sultana and N. Akther*
029 Bio-accumulation of Chromium and Cadmium in Commercially Edible Fishes in Gangetic West Benal --*AK Bhattacharya, SK Das and SN Mandal*
039 Studies on Seasonal Distribution of Heavy Metals in Water and Sediment Phase with Its Bio-accumulation in Upper Stretch of Gangetic West Bengal *AK Bhattacharya, SK Das, SN Mandal and A. Mitra*

Session 3: 29/12/03, 3:45pm: DCE Meeting Room
Session Chairman: Mr. MB Zaman
Co-chairman: Dr. SN Mondal

007 Investigating the Possibility of Recycling the Contaminated Plastic Containers *H. Omar and P. Michael*
024 Technological Capacity Building: The Role of Process Innovation and Adaptation -- *MK Uddin*
044 Application of High Pressure Technology in Food Processing and Preservation A Kinetic Case Study On the Thermal and High Pressure Inactivation of Pectin Methyl Sterase in Tomato Juice -- *N. Sultana*
055 Effect of Oxygen Concentration and Turbulence on Acid Corrosion of Brass -- *MAA Dewan and M J Alam*
056 Surface Morphology of Nimo/$Al_2^0{}_3$ Catalyst Containing Boron and Phosphorus -- *D. Ferdous, AK Dalai and J. Adjaya*

Session 4: 30/12/03, 2:00pm: DCE Meeting Room
Session Chairman: Dr. Iqbal Mahmud
Co-chairman: Dr. J. Zaman

022 Imbedding Assessment and Achievement of Course Learning Objectives with Periodic Reflection -- *S. Ilias and FG King*
023 Using Standardized Examination to Assess Engineering Programs -- *S. Ilias, KA Schimmel and FG King*
042 Application of Computational Fluid Dynamics in the Process Industries: Current Capabilities and Future Challenges -- *T. Mahmud*
047 Chemical Engineering Principles in Coronary Implant Drug Delivery Devices: Predictive Mass Transport Modeling within the Coating and Local Pharmacokinetics in Coronary Lesion -- *SFA Hossainy and S Prabhu*
050 Reactive crystallization of Brushite: Modelling and Experiment -- *SM. Arifuzzaman and S. Rohani*
053 Real Time Data Acquisition and Control with LabVIEW -- *MT Yasser and HN Mondal*

Session 5: 30/12/03, 2:00pm: DCE Lecture Room
Session Chairman: Dr. MN Karim
Co-chairman: Mr. Mostafizur Rahman

013 Removal of Arsenic from Ground Water by Adsorption -- *SA Iqbal, MZ Abedin and M. Abu Zafar*
025 Biosorption of Basic Dyes Using Sewage Treatment Plant Biosolids -- *MZ Alam*
028 Improved Decolorization of Reactive Dye Effluents Using Coagulant Aid and Polyelectrolyte -- *AK Bhattacharya, SK Das and SN Mandal*
043 Encapsulated Phase Change Materials for Thermal Energy Storage system -- *MS Uddin, MNA Hawlader, MM Khin and SL Yan*
049 Study and Evaluation of Alum Based Arsenic Removal Plant -- *S. Barua and JA Suborna*
054 A Study of Arsenic Waste Disposal System by Sublimation Process -- *W. Alam, EC Donaldsom, N. Begum, MK Paul and AKMA Quader*

Session 6: 30/12/03, 2:00 pm; IAT Lecture Room
Session Chairman: Dr. N Ahmed
Co-chairman: Dr. Omar Houache

002 A Diesel Hydrotreater Complex in Saudi Aramco Riyadh Refinery, Riyadh.-- *KSA K Rashid*
003 Low Temperature Hydrogen production From Ethanol -- *N K Das, AK Dalai and R Rongathan*
010 Optimization of Industrial Heat Exchangers Network -- *AS Ashaibani and I M Mujtaba*
015 All Ceramic Solid Oxide Fuel Cell Stack Development at CFCL -- *K Ahmed, R Ratnaraj, J Love and K Foger*
020 Gas-Liquid Flow Through Coils -- *AB Biswas, SN Mandal and S K Das*
026 Study On the Production of Carboxymethyl Cellulose On Pilot Scale -- *M R Karim, F N Ahmed and A Hossain*

Session 7: 30/12/03, 3:45 pm; IAT Lecture Room
Session chairman: Dr. Shamsuddin Ilias
Co-chairman: Mr. Rehman Morshed

006 PVD-Coating For Processing of Textiles *H Kabir, J Matthess, Y. Dietzel, P. Offermann, G. Nocke and K. Matthess*
033 Improving Plant Performances-Lessons From the Experience of Karnaphuli Fertilizer Company Ltd. -- *Sk S Ahmed.*
037 An Experimental Investigation On the Removal of Ammonia from Wastewater in a Tapered Bubble Column -- *PS Mandal, B Basak and SK Das.*
038 Ammonia Leakage From a Refrigeration Plant Case Studies -- *RK Gangopadhyay, M Mukherjee and SK Das.*
040 Pilot Plant Study For the Stabilization of Rice Bran -- *N Sharmin, S Kamruzzaman and A Hossain*
051 Study on Shrinkage Loss in Dyeing and Finishing of Nylon Fabrics at Savar Dyeing and Finishing Industries Ltd, -- *MS Islam, MS Ali and M Rahman, A Hossain and M Mohiuddin*

Session 8: 30/12/03 , 3:45 pm; DCE Lecture Room
Session Chairman: Mr. Kamal Rashid
Co-chairman: Dr. MS Islam

011 Neural Network Based Seawater Physical Property Calculations Within MSF Desalination Process Model -- *MS Tanvir and IM Mujtaba*
014 Affordable Virtual Reality Technology in Chemical Engineering -- *M Iqbal, MS J Hashmi and SA Iqbal*
035 Simulation of Kailsahtilla-1 Gas Processing Plant -- *N Sharmin and AKMA Quader*
036 Simulation of Kailashtilla-II Gas Processing Plant -- *S Kamruzzaman and AKMA Quader*
041 Permeability of Rubbery and Glassy Polymers-An Interface Reaction Model -- *M A Islam*
048 Characterization of Reservoir Fluids of Saldanadi Gas Field -- *MA Islam and KBMA Ahad.*

Session 9: 30/12/03, 3:45 pm; DCE Meeting Room
Session Chairman: Dr. M Sabder Ali
Co-chairman: Mr. MA Matin

004 Pipeline Risk Management Programme -- *F. Chowdhury*
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