Students Brief

THE CHEMICAL INDUSTRY

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Chemistry has always been of fundamental importance to human life and the origins of the chemical industry date back to the origins of civilisation itself. The use of fire, the baking of clay, the use of dyes etc are all chemical processes but probably most people associate the origins of chemistry with the 15th century alchemists who sought to convert abundant materials into valuable commodities. In particular, the principal aim of the alchemist was to find the Philosopher's Stone, a mysterious agent which possessed the properties of producing gold and prolonging life. Certainly they never succeeded in creating gold but many permanent, beneficial spin-offs were effected resulting in the science of chemistry, which has indeed contributed to prolonging life. Simpson's introduction of chloroform to surgery in 1847, Lister's discovery of carbolic acid as a disinfectant in 1867 and Fleming's discovery of penicillin in 1928 are well-documented examples.

Industry Structure

In our modern world, the chemical industry occupies a sprawling, ill-defined terrain at the heart of every industrial economy. Its boundaries can only be delineated in a very arbitrary way since so many other industries such as brewing, steel and paper are in effect complex chemical processes. Thus from a statistical point of view definition of the chemical sector can be very confusing. For example, the OECD and United Nations include Manmade Fibres and Synthetic Rubber in the chemical industry but both exclude Plastics. On the other hand, the European Petrochemical Association does include Plastics. Similarly, when making inter company comparisons, there is often the difficulty of deciding whether a company is primarily concerned with chemicals in one form or another or whether it really belongs to another industry. Therefore the interpretation of statistics is fraught with pitfalls and the user must try to be consistent.

In the UK the chemical industry is regarded as comprising those sub-sectors shown in Table 1.

These sub-sectors in turn are dominated by huge multinationals each with a massive international spread of investments and together they produce the 60,000 chemical products in use in the world today. The twenty largest chemical companies in the world in 1980 outwith the USA are shown in Table 2. The major UK chemical companies in 1979 are shown in Table 3 and such

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*The views expressed are those of the author and not necessarily those of the Fraser of Allander Institute.

TABLE 1 THE UK CHEMICAL INDUSTRY IN 1979

Sub-Sector	**Output (£m)**	**Consumption (£m)**	**Exports (£m)**	**Imports (£m)**	**Employees (000)**	**Capital Expenditure (£m)**
Organic Chemicals	2,722	2,506	1,251	1,035		255.7
Inorganic Chemicals	1,153	1,207	293	347	136.4	149.9
Other General Chemicals	1,543	1,056	971	484		150.3
Pharmaceut.	1,675	1,303	602	230	72.8	138.5
Toilet Prep.	591	504	161	74	24.4	30.5
Paint	732	655	119	42	25.9	26.9
Soap & Det.	707	607	156	56	25.9	25.1
Synthetic Resins	1,836	1,919	720	803	52.2	168.1
Synthetic Rubber	164	182	72	82		
Dyestuffs	430	303	249	122	20.4	65.8
Fertiliser	584	622	58	96	11.4	75.0
Other Chem.	1,661	1,470	559	368	66.6	77.0
Total Chem. Industry	13,798	12,334	5,211	3,739	427.0	1,163

Source: National Economic Development Office

Note: Figures for employment refer to June 1980

firms impinge more and more upon every facet of our daily lives - the home, food, clothing, transport, work, recreation, health, even crime detection. Many of the world's major chemical firms have a presence in the UK but in addition there are opportunities for medium sized and small companies which meet the requirements of particular users where these needs are too small to attract the attention of the giant companies. The location of these companies in the UK tends to be dictated by geographical and economic reasons. For example, in the Strathclyde region of Scotland, there are approximately 100 chemical companies producing the whole spectrum of chemicals and they are located there for a number of reasons. The industry requires vast quantities of water which must be of pure quality and Strathclyde is fortunate in having a plentiful supply which is almost completely free from calcium and magnesium salts. Furthermore, substantial capital investment is currently underway on several new water supply schemes, which will together add a further 40 million gallons per day to capacity, and on sewereage treatment and disposal - nowadays a very sensitive problem and justifiably so. The region is also served by an extensive mororway network, rail freight and excellent port facilities while the two airports at Glasgow and Prestwick provide extensive domestic and international connections. Moreover, the region's universities and colleges produce a substantial pool of graduates and other technically qualified personnel as well as providing various opportunities for basic research. Indeed, many chemical firms have developed close links with them.

TABLE 2 LARGEST CHEMICAL COMPANIES OUTWITH THE USA BY SALES (1980)

Company	**Country**	**Sales ($m)**	**Assets ($m)**	**Net Income ($m)**	**Employees**
Hoechst	W Germany	16,481	12,329	252	186,850
Bayer	W Germany	15,881	13,453	356	181,639
BASF	W Germany	15,277	9,264	198	116,518
ICI	UK	13,290	14,535	- 47	143,200
Montedison	Italy	9,104	9,913	-524	105,532
DSM	Netherlands	7,514	4,511	13	31,410
Rhone-Poulenc	France	7,155	6,527	-461	95,389
Ciba Geigy	Switzerland	7,113	9,878	182	81,184
Akzo	Netherlands	6,272	4,470	- 35	83,100
Charbonnageo de France	France	4,959	5,180	- 50	77,600
Solvay	Belgium	4,742	3,885	59	49,057
Mitsubishi Chemical	Japan	4,127	4,374	42	14,066
Roche/Sapac	Switzerland	3,496	5,421	138	43,643
Sumitomo Chemical	Japan	3,181	3,073	39	11,898
Asahi Chemical	Japan	3,103	2,824	95	20,779
Sandoz	Switzerland	2,926	3,234	121	35,459
British Oxygen	UK	2,710	3,406	60	44,700
Chemische Werke Huls	W Germany	2,678	1,463	34	18,063
Toray	Japan	2,644	2,550	72	22,093
L'Air Liquide	France	2,614	2,509	134	25,000

Source: Fortune

Note: Financial data have been converted to US dollars at the average official exchange rate during the company's fiscal year. Shell, Courtauld and BP do not appear in this Table because they are regarded by **Fortune** as belonging to alternative industries.

In general, however, major chemical complexes tend to be located at coastal locations, most notably BP's Grangemouth complex with employs 2,400 people and manufactures 750,000 tons of chemicals and plastics per year using feedstocks from the adjacent BP oil refinery. This site covers 470 acres of which 170 are still available for future expansion and much of the chemicals output goes "over the fence" to neighbouring chemical plants such as Bakelite/Xylonite (now part of BP), Borg Warner and Industrial Synthetic Rubber. The major locations of UK bulk polymer production along with companies involved and capacities are shown in Table 4.

As an example of a small specialist firm, one is particularly worthy of note. The small Yorkshire firm, Phosyn Chemicals was set up in 1967 by two partners to manufacture trace element fertilisers for particularly difficult regions of the World. Six years ago the company visited Libya after

TABLE 3 THE LARGEST UK CHEMICAL COMPANIES BY SALES (1979)

Company	Sales ($m)	Assets ($m)	Net Income ($m)	Capital Expenditure ($m)	Research Expenditure ($m)
ICI	11,755.9	9,752.1	908.9	1,664.4	405.2
Shell Chemicals	6,808.7	4,614.3	N/A	906.7	N/A
Courtaulds	3,638.9	1,770.0	95.9	110.6	N/A
BP Chemicals	3,116.4	2,507.6	N/A	300.0	N/A
British Oxygen	2,691.5	2,409.0	65.7	289.5	N/A
Beecham	2,021.6	1,396.6	178.7	105.8	68.5
Unilever	1,414.7	N/A	N/A	67.9	N/A
Glaxo	1,180.5	789.9	79.7	92.3	71.2
Fisons	948.3	538.1	28.9	37.4	31.6
Wellcome	901.3	699.5	N/A	59.1	85.6

Source: Chemical Age

learning that the country was trying to grow wheat in the Sahara Desert. Soil samples showed which vital elements the desert lacked and within two years Phosyn had improved the wheat yield by 140%. The company has since gone on to apply its expertise to other agricultural problems in twelve countries, custom-manufacturing products to suit special needs - a classic example of market orientation.

Sulphuric acid is an important chemical which quickly loses its identity as a product and is rarely encountered directly in daily life (except perhaps in vehicle batteries), but it is a chemical upon which many other industries depend. Hence, fluctuation in the production of this "workhorse chemical" is often regarded as a barometer of the state of an industrial nation as a whole, although some chemists would argue that the production of the petrochemical ethylene, the building block of the modern chemical industry, is of more interest. Indeed, in the UK, output of the petrochemical sub-sector is about 25% of the total chemical industry, involves around 25 companies with ICI, Shell Chemicals BP Chemicals and Esso Chemicals dominating and employs roughly 75,000 people. In the EEC, the chemical sector contributes about 10% of the gross value added of manufacturing industry, ranking fourth after food, engineering and transport equipment. With regard to gross formation of capital, the chemical sector comes first illustrating the very capital intensive nature of the business. Total new capital invested by the European chemical industries during the 1970's and 1980 is shown in Table 5.

Capital expenditure during the first half of 1981 was £605 million which is some 16% down on the same period of 1980. Given the present levels of surplus capacity, low profitability and poor growth prospects, several companies have indicated further cutbacks in their future investment plans.

Despite being highly capital intensive and despite the very rapid rate of technological change in this industry, the chemical sector is still a major employer in the UK although admittedly there has been a steady drop over the past decade from 443,000 at the end of 1970 to 431,000 at the end of 1980. This latter figure does of course mask significant short time working.

TABLE 4 PRODUCTION LOCATION OF MAJOR BULK POLYMERS

Material	Company	Capacity	Location
Low Density Polyethylene	BXL (BP Chemicals)	100,000	Grangemouth
	ICI	200,000	Wilton
	Monsanto	45,000	Fawley
	Shell	160,000	Carrington
High Density Polyethylene	BP Chemicals	134,000	Grangemouth
Polypropylene	ICI	200,000	Wilton
	Shell	150,000	Carrington
Polystyrene	Dow	70,000	Barry
	Shell	80,000	Carrington
	ATO (UK)	60,000	Stalybridge
Poly Vinyl Chloride	BP Chemicals	150,000	Barry
	British Industrial Plastics	90,000	Aycliffe
	ICI	400,000	Runcorn
	Vinatex	60,000	Staveley
Acrylonitrile Butadiene Styrene	Borg Warner	70,000	Grangemouth
	ISR/Polymon	30,000	Hythe

Source: European Plastics News

Note: Capacity is in tonnes

TABLE 5 TOTAL NEW CAPITAL INVESTED BY EUROPEAN CHEMICAL INDUSTRIES ($M)

Country	1969-78		1979		1980	
	Inv.	%	Inv.	%	Inv.	%
France	8,382	14	1,229	13	1,544	13
W Germany	19,295	31	3,290	34	3,681	31
Italy	12,515	20	1,449	15	1,938	16
Netherlands	5,808	9	671	7	673	6
UK	10,508	17	2,319	24	3,234	27
EEC	61,344	100	9,644	100	11,762	100

Source: Chemical Industries Association

Note: Percentages refer to share of total EEC investment

It is perhaps significant to point out that reported accident figures in this industry are marginally greater than for the manufacturing sector as a whole. What these figures do not capture is the insidious development of disease which often only manifests itself after many years. Long exposure to low concentrations of certain chemicals is now suspected of being carcinogenic. Even when the dangers are known, the problems are often ignored until an embarrassingly high incidence of disease forces an investigation and perhaps compensation.

A report published in Britain in 1921 warned of the hazards of several chemicals, one of which was manufactured right up to 1967 while, only recently, seven former workers from Ciba-Geigy in Paisley, Scotland, who contracted bladder cancer, won a civil action for compensation. It is hoped that the most stringent control over employee and consumer safety will be enforced as the chemical industry now enters the uncharted waters of biotechnology.

Market Structure

Demand for the output of the chemical industry derives from a very broad range of users although the industry itself consumes much of its own output for further processing. Some indication of the source of demand for the output of the chemical industry may be gleaned from Table 6 which was prepared from a recent input/output study of the Scottish economy. There is no reason to expect that the source of demand will be terribly different in the rest of the UK. Figures for the consumption of each individual class of chemical are very sparse but Table 7 provides UK consumption statistics for 18 different types of plastic during 1980 and 1981.

Interestingly, only nine of these eighteen plastics actually showed any increase over the period while the remaining nine, which showed declines or no change, reflected the fortunes of the principal user industries.

TABLE 6 SOURCE OF DEMAND FOR OUTPUT OF SCOTTISH CHEMICAL INDUSTRY (1973)

Sector	%	Sector	%
Agriculture	8.5	Man-Made Fibres	1.2
Bakery/Other Foods	2.3	Metals	4.0
Brewing	0.6	Motors	0.7
Bricks/Building Materials	1.5	Paper	3.0
Chemicals	30.5	Plastics	2.0
Coal/Other Mining	1.2	Road Transport	1.8
Construction	4.2	Rubber	3.4
Electricity	3.7	Spinning/Weaving	1.4
Gas	0.8	Whisky	0.8
Glass	0.6	Other	18.5
Health Service	9.3		

Source: Input/Output Tables for Scotland, 1973

Therefore of major concern in this current recession is the number of chemical consumers who are being forced to close or contract and the rapid rate of this process of contraction. In particular, high levels of import penetration in the motor and textile industries are severely affecting demand for a whole range of chemicals. The difficulties are aggravated by two problems outwith the industry's control.

(a) The deterioration in the international competitiveness of the industry over the past couple of years due to a combination of the strong petropound and relatively high rates of inflation in the UK means that it has been more difficult if not impossible, to direct output to export markets. It has been estimated by one company chairman that for every £1 by which high sterling reduces imported raw material costs, export earnings fall by £2. Hence a net loss. The problem has of course been compounded by the high levels of interest rates in the UK which add greatly to business uncertainty. Admittedly these problems are slowly beginning to ease now but it is unlikely that cost increases will be fully passed on until there is further substantial recovery in demand.

(b) The Chemical Industry Association calculates that UK chemical firms pay £200 million more for energy than their major European competitors. Oil prices are higher than Continental prices due to UK oil product taxes - a curiously perplexing situation for a major oil producer - while gas and electricity prices present a problem. Not surprisingly, the industry has welcomed the decision by the Conservative Government to abolish British Gas's monopoly on the supply of new gas from the North Sea.

Recent Background

Much of the current depression overhanging the chemical industry has, to some extent, been of its own making. Soon after it took off in the 1950's, the industry achieved supernormal growth rates often more than double the growth rates of many national economies. Indeed, in the decade leading up to the oil crisis of 1973, the world chemical industry more than doubled its own output. This exceptional growth occurred for a variety of reasons.

The world economy grew rapidly in the 1960's and the expansion of many industries had a boosting effect on the demand for chemicals. In addition, low, stable crude oil prices and the apparent security of supply meant that many traditional materials such as steel and natural fibres could be readily and cheaply replaced by plastic and chemical fibres. During the 1960's, for example, calculations show that substitution by plastics ran at an annual growth rate of approximately 10%. Finally, technical progress enabled chemical producers to enjoy the fruits of economies of scale with the annual capacity of plants being increased some twenty-fold between the 1950's and 1970's, so generating more cost effectiveness.

As predicted by economic theory, the abnormal profits available attracted even more investment expenditure. Between 1969 and 1978, total new capital invested by the European chemical industry was $61,344 million, 17% of which was accounted for by the UK. For 1980 alone the figure was $11,762 million, 27% by the UK. Despite indications of overcapacity the chemical companies continued their investment programmes on the assumption that

TABLE 7 UK PLASTICS CONSUMPTION (thousand tonnes)

Plastic	**Some Common Uses**	**1980**	**1981**
Low Density Polyethylene	Sacks, Carrier Bags	425	422
High Density Polyethylene	Container Drums, Pipes	155	169
Polypropylene	Domestic Appliances, Carpets	205	225
Poly Vinyl Chloride	Footwear, Window Frames	367	372
Polystyrene	Food Packaging eg eggboxes	126	130
Expanded Polystyrene	Cavity Wall Insulation	21	23
Acrylonitrile Butadiene Styrene	Refrigerator/Washing Machines	45	40
Polyamides	Nylon	17	16
Acrylics	Baths, DIY, Double Glazing	23	25
Acetals	Car, Plumbing Components	6	6
Polyethylene Terephthalate	Plastic Bottles	5	12
Polyester Film	Packaging	17	18
Amino Plastics	Adhesives	135	123
Phenolics	Car Components	65	58
Polyurethanes	Furniture/Beddings	84	84
Epoxides	Automotive Paints	13	13
Polyester Resins	Glass Fibre Goods	45	40
Other		240	242
TOTAL		1,994	2,018

Source: European Plastics News

demand would continue to grow strongly which, as suspected, has been wildly overoptimistic. Some evidence of this is shown in Table 8. In fact it is considered that present Western European capacity is sufficient to meet demand until 1990. This problem of overcapacity has been aggravated by:-

(a) Oil companies moving into chemicals when, after the various 'oil crises' of the 1970's, they could no longer sustain their previous profitability purely from the supply of oil.

(b) The Middle East, North African, Latin American and other Third World countries wanting to establish their own chemical industries either to substitute for expensive chemical imports by using their own feedstocks or to develop alternative industries for when their own reserves are exhausted. Projects in such countries are usually executed in the form of joint ventures with Western European or Japanese chemical or oil companies who supply the necessary capacity and expertise in exchange for much needed oil and gas. In this way, Japan in particular will import their petrochemical requirement from the Middle East while its domestic chemical industry will concentrate on high value added products like pharmaceuticals. Planned ethylene capacity in the Middle East is shown in Table 9.

(c) COMECON countries, desirous of becoming self-sufficient in chemicals and in their chase for hard currencies, undercutting the West's prices. For example, the price of Low Density Polythylene (LDPE) from Eastern Bloc countries was recently £60 per tonne cheaper than in the West. Ironically, when the West sells technical expertise and plant to these newcomers, it is usually paid for by so-called "compensatory deals" whereby payment is made either wholly or partly in the chemical output produced.

Such are the major contributory factors in the present price collapse and the low if not negative rates of return on investment. In response to these problems, some chemical companies have adopted a number of strategies.

(a) "Backward Integration" whereby a chemical company moves into the oil business eg ICI has a stake in the Ninian Oilfield.

(b) Joint-ventures with oil companies.

(c) Abandoning petrochemical production, leaving it to the oil companies and moving upmarket to high value added chemicals like drugs which are cyclically insensitive. Indeed the West German Hoechst Group has estimated that World demand for pharmaceuticals will treble over the next twenty years.

(d) Exploiting the relative strength of sterling and investing in the USA where the American chemical industry enjoys extensive economies of scale from access to a large domestic market and from the extensive use of natural gas as a cheaper chemical feedstock. Thus, for example Unilever paid $485 million for National Starch and BOC paid $470 million for Airco.

TABLE 8 ETHYLENE CAPACITY AND PRODUCTION IN WESTERN EUROPE

	1970	1973	1975	1978	1980
Capacity (m tonnes)	6.8	10.9	12.7	14.0	15.0
Output (m tonnes)	5.9	9.6	8.0	10.5	10.0
Utilisation Rate (%)	87	88	63	75	67

Source: Barclays Bank

These are essentially medium to long-term strategies but in the short-term many companies have sought instant savings by cutting back on capital expenditure in both plant and research and development (R/D). However the chemical industry has no future without R/D especially in such an intensely internationally competitive industry. The average time spent by a chemical company in developing a new product is seven years and costs as much as $10 million. Total R/D expenditure in 1966 and 1978 was £218 million and £284 million respectively, but recent company annual reports suggest that this will be revised downwards in the 1980's while University/Polytechnic expenditure cuts will have similar detrimental effects. While successive governments have stressed the importance of R/D for the long term health of the UK economy, their support has been heavily biased towards electronics and aerospace. The chemical industry is now seeking either tax incentives or cash grants financed by North Sea oil revenue to support R/D arguing

TABLE 9 PLANNED ETHYLENE CAPACITY IN MIDDLE EAST (m tonnes per year)

Country	Capacity
Algeria	0.5
Egypt	0.3
Iran	0.3
Iraq	0.1
Kuwait	0.3
Libya	0.3
Morocco	0.2
Qatar	0.3
Saudi Arabia	1.3
TOTAL	3.6

Source: Middle East Economic Digest

TABLE 10 PROJECTED CONSUMPTION OF CHEMICALS (million tonnes)

	1976 (Actual)				1990 (Projected)			
Product	West Europe	East Europe	U.S.A.	Japan	West Europe	East Europe	U.S.A.	Japan
Ethylene	10.4	2.4	10.2	3.8	20.0	9.0	17.3	7.7
Plastics	15.8	6.0	12.2	4.9	32.0	15.0	22.0	12.0
Synthetic Rubber	1.8	2.1	2.2	0.7	2.1	N/A	2.2	0.9
Cellulose Fibres	0.6	1.2	0.4	0.2	0.3	1.3	0.1	0.1
Non-Cellulose Fibres	2.0	1.0	2.6	1.2	3.5	2.5	3.6	N/A
Nitrogenous Fertilisers	8.7	11.9	9.6	0.7	12.0	21.0	16.0	0.7
Soaps & Detergents	5.9	2.5	6.0	N/A	9.7	3.9	9.1	N/A
Paints & Varnishes	4.7	4.4	4.4	1.4	7.8	N/A	5.9	2.7

Source: OECD

Note: Eastern Europe includes USSR

that,

"This would not be using resources to prop up declining industries, but would be transferring one asset into another, investing current revenue into a potentially greater revenue earner in the future. It could be regarded as a very appropriate way of conserving North Sea resources and allowing the UK to benefit from them over a much longer period than the current production estimates will provide." (Chemicals Development Committee.)

Chemical projects planned, in construction or completed in Scotland in 1980 are shown in Table 12.

Future Prospects

The immediate future of the UK chemical industry depends fundamentally upon a healthy domestic economy. However, despite marginal improvements on this front, there are still many black clouds on the horizon. The low and sometimes negative trends in end-user industries such as textiles, cars, tyres, white goods etc are not only likely to inhibit new capital investment in more efficient plant but may also result in more closures. This could be especially deleterious for the long term since consumption of most chemicals, particularly ethylene and plastics, is expected to rise quite substantially in the 1990's as shown in Table 10.

In addition the artificially high cost of energy and raw materials relative to the USA is particularly damaging and is clearly disadvantageous to the industry even with the slight changes announced in the 1982 Budget. In this respect the optimum utilisation of ethane and other natural gas liquids from the North Sea becomes especially crucial and will become even more important as world oil supplies are depleted. Britain's offshore natural gas supplies are shown in Table 11.

Early in 1980, British Gas and Mobil Oil undertook a joint feasibility study of the construction of a pipeline costing £1.1 billion to gather an estimated 21 billion cubic feet of gas worth around £30 billion in 1980 prices from 21 North Sea oilfields. Such gas is typically flared off. The pipeline had been approved by the Government and it was expected that the necessary finance would be provided by a consortium of interests particularly British Gas itself, BP, Mobil and various banks. Having been landed at St Fergus in North East Scotland, the methane gas was to be sold to British Gas and fed into the national network while the other valuable chemical feedstocks such as ethane were to be sent South by pipeline to existing petrochemical plants at Mossmoran in Fife (Shell and Esso) on to Grangemouth (BP) and thereafter to Wilton on Teesside (ICI). The availability of this gas-based naphtha would have given the UK chemical industry a very substantial commercial edge. Eventually some gas may also have been piped West to Nigg Bay where Dow Chemicals, Occidental Petroleum and Highland Hydrocarbons wish to set up new plants with very important benefits to this depressed region. Unfortunately, this integrated gas gathering pipeline has been shelved, hopefully only temporarily, due to disagreements over financing and individual companies are currently appraising private gas gathering projects of their own.

TABLE 11 BRITAIN'S OFFSHORE NATURAL GAS SUPPLIES

Field	Discovered	Production Began	Gas Ashore in 1977 million cubic metres	Recoverable Reserves billion cubic metres
West Sole	1965	1967	1,944	61
Leman Bank	1966	1968	15,525	292
Hewett	1966	1969	7,776	97
Indefatigable	1966	1971	6,760	125
Viking	1968	1972	6,285	125
Rough	1968	1975	1,057	14
Frigg UK	1972	1977	613	128
Frigg Norway	1971	1977	952	192
Forties	1970	1977	-	N/A
Piper	1973	1978	-	N/A
Brent	1971	1980/81	-	84
Tartan	1974	1980/81	-	N/A
Morecambe	1974	1984	-	56-84

Source: "Gas" by Richard Cassidy

Note: Estimates of reserves for Forties, Piper and Tartan are not available as production depends on oil recovery.

Finally, ecological considerations and the growing power of environmentalists will almost certainly place a heavy financial burden on many chemical companies in the future. Chemicals present one of the great paradoxes of the 20th century. Over the past thirty years or so, advances in the chemical sciences have probably done more to improve the quality of life in modern society than any other technology. There are few industries which are not served by chemicals and progress in medicine, agriculture and consumer proucts etc are legend. But, the legacy of this progress is found not only in live-saving drugs and products to make life more congenial but also in a polluted environment and increasing evidence of negative long-term effects of chemical accumulation on human health. Because of the sheer number of chemicals in use and the fact that about 1,000 new chemicals appear each year, there is a growing need to reconcile environmental considerations with those of economic growth. Already it is estimated that 12% of the total cost of a 500,000 tonnes per annum US ethylene plant is associated with environmental control systems.

TABLE 12 CHEMICAL PROJECTS PLANNED, IN CONSTRUCTION OR COMPLETED IN SCOTLAND, 1980

Company	Location	Project	Cost £m	Contractor
Bakelite Xylonite	Grangemouth	Polyethylene	-	Mathew Hall
Beechams	Irvine	Multi-purpose	-	-
BNOC	Nigg Bay	Storage	50.0	G Wimpey
British Oxygen	Gartcosh	Nitrogen	-	Cryoplants
Borg Warner	Grangemouth	Resin	-	Catalytic International
BP Chemicals	Grangemouth	Ethanol	57.6	Davy McKee/M Hall
BP Chemicals	Grangemouth	Polyethylene	-	Crawford/Russell
Cromarty Petroleum	Nigg Bay	Petrochemicals	750.0	-
Esso Chemicals	Mossmorran	Ethylene	300.0	Lummus
Hoffman La Roche	Ayrshire	Bleach-dye)		Uhde
Hoffman La Roch	Ayrshire	) Vitamin C)	125.0	Foster Wheeler
ICI	Grangemouth	Pharmaceuticals	3.0	-
ICI	Ayrshire	Nitrocellulose	3.0)	
ICI	Ayrshire	Effluent Control	10.0)	Babtie Shaw & Morton
ICI Organics	Grangemouth	Dyes	17.0	Sim-Chem.
National Semi-conductor	Greenock	Nitrogen	-	Air Products
Nobels Explosives	Ardeer	Explosives	-	Chemetics
Norit Clydesdale	Cambuslang	Carbon	12.0	Crawford/Russell
Occidental	Flotta	Ethane	250.0	Humphreys & Glasgow

Source: Chemical Age