3.1.4.3 DMT/TPA

Dimethyl terephthalate (DMT) and purified terephthalic acid (TPA) are used in terephthalate polyester resins and films. Specific uses evaluated here are polyethylene terephthalate (PET) film, polybutylene terephthalate (PBT) resins, and polyethylene terephthalate (PET) barrier resins.

3.1.4.3.1 MARKETS

The estimated 1977 and future markets for terephthalate polyester resins and films is shown in Table 3.17.

3.1.4.3.2 POLYETHYLENE TEREPHTHALATE (PET) FILM

PET film is presently the largest of the resin and film markets. Photographic film is the largest market in PET film and it will continue to be. Most of the readily displaceable markets where cellulose acetate was previously used have been captured by PET film. The key application in this area has been x-ray film. Continued PET penetration is expected in other photographic film markets. Cellulose acetate is expected to remain the preferred motion picture film.

The magnetic tape market has matured in the key initial growth area, computer tape. Auto tape and video tape markets will be the growth areas for PET magnetic tape led by cassette tapes and home video markets, respectively.

PET film has competed successfully against cellophane and will continue to do so. Metallic film used in packaging is also expected to grow well.

The smaller markets for PET film shown in Table 3.17 will grow faster than total PET film but the smaller market sizes lessen the importance of these markets.

PET film is produced from both DMT and TPA as shown in Table 3.18. Unlike the fiber market where TPA has displaced DMT, DMT is expected to continue as the dominant material for PET film.

3.1.4.3.3 POLYBUTYLENE TEREPHTHALATE (PBT) RESINS

Since their introduction in 1970 PBT-based plastics have grown to over 40 million pounds of useage in 1977. Excellent growth is expected to continue.

Automotive and truck components and parts, which is the largest market presently for PBT resins, will face stiff competition from reaction injection-molded polyurethanes. Under-the-hood applications are expected to be the largest growth area in automotive due to warpage problems with large exterior PBT parts.

Electrical and electronic components and parts will be the major growth market for PBT resins. PBT resins have better dimensional stability and flame-retardant properties than thermosets and will continue to displace thermosets in this market.

PBT engineering thermoplastic resins are produced by polycondensation of DMT with 1,4-butanediol. TPA is not used because it catalyzes the cyclization of 1,4-butanediol to tetrahydrofuran during the polycondensation.

3.1.4.3.4 POLYETHYLENE TEREPHTHALATE (PET) BARRIER RESINS

PET barrier resins are used for the production of carbonated beverage bottles. Nitrile barrier resins initially were competitive with PET until late 1977 when the FDA banned acrolynitrile resins for bottle use. Subsequently, the use of PET resins in this market has exploded.

Legislation will also affect growth projections for PET barrier resins. PET beverage bottles will not continue to be used in any states that enact deposit laws specifying refilling bottles (such as now in effect in Vermont). The future of PET beverage bottles in states that enact deposit laws not requiring refillability is less clear.

To date, market penetration for PET soft drink bottles has been in the 2-liter "family" sizes. One liter sizes are also produced. The projections shown in Table 3.17 assume continued rapid penetration of the bottle market by PET barrier resins.

Nearly all of the PET barrier resin produced in the U.S. is based on TPA. This is expected to continue.

3.1.4.3.5 SUPPLY/DEMAND BALANCES

Table 3.18 shows projected supply/demand balances for DMT/TPA use in PET fiber, PET film, PET barrier resin, and PBT resin uses. As the table indicates, new TPA capacity is required by 1987.

Table 3.16 compared the conventional p-xylene and CO routes to TPA for various plant start-up years. Conventional technology is expected to be the cheaper route in 1987. No CO market is projected for new TPA technology.

Table 3.17

U.S. TEREPHTHALATE POLYESTER RESIN AND FILM MARKETS
(MM Pounds)

	1977	1982	1987
PET Film			
Photographic Film	135	200	300
Magnetic Tape	50	75	115
Packaging	30	50	85
Electrical	23	30	40
Metallized Film	20	40	70
Other	52	85	125
	310	480	735
PBT Resins			
Auto and Truck	18	40	70
Electrical and Electronic	14	45	110
Other	11	30	50
	43	115	230
PET Barrier Resins			
Beverage Bottles	30	500	800
Total	383	1095	1765
TPA	90	640	1025
DMT	293	455	740

Table 3.18

DMT/TPA SUPPLY-DEMAND BALANCES
(MM lbs.)

	1977		1982		1987	
	DMT	TPA	DMT	TPA	DMT	TPA
PET Fiber	2000	1270	2000	2520	2000	3070
PET Film	250	60	370	110	545	190
PBT Resins	43	0	115	0	230	0
PET Barrier Resins	0	30	40	460	50	750
Exports	150	75	150	100	150	150
Effective Capacity	4250	3200	3000	3200	3000	3200
Capacity Required	(1817)	(1768)	(325)	(10)	(25)	1160

3.1.4.4 ACETIC ANHYDRIDE

Acetic anhydride is used primarily for production of cellulose acetate and other esters.

3.1.4.4.1 MARKETS AND SUPPLY/DEMAND BALANCE

Markets for cellulose acetate are dominated by production of textile fiber and flake and also cigarette tow. Specific market projections are shown in Table 3.19.

Present capacity for production of acetic anhydride will be adequate until the mid-1980's. That capacity is based heavily on ketene technology involving the "dehydration" of acetic acid. In the early 1980's existing anhydride producers must decide between continuing to run existing ethylene/acetaldehyde/acetic acid/acetic anhydride technology and construction of new anhydride capacity, possibly involving new technology.

Economic evaluations comparing CO/methanol technology and conventional ketene technology were shown in Table 3.16. New syngas technology appears to be the technology of choice for a plant to be constructed early in the 1983-1987 period. In addition to the 15 million gallons per year of methanol for a 250 million pound per year anhydride plant, approximately 3.5 MMSCFD CO would be required as plant feedstock.

3.1.4.5 HEXAMETHYLENEDIAMINE (HMDA) ADIPIC ACID, AND CAPROLACTAM

3.1.4.5.1 HMDA

HMDA is currently produced using five different processes. Four of the five require hydrogen for reduction of adiponitrile to HMDA. All plant expansions and new plant commitments are expected to use one of two routes, both of which require reduction of adiponitrile with H_2. Cyclohexane is not expected to be used as a raw material for production of HMDA in any future plant expansions or new capacity.

Table 3.19

ACETIC ANHYDRIDE MARKETS
(MM lbs.)

	1977	1982	1987
Textile Fiber	414	377	344
Textile Flake	176	196	218
Cigarette Tow	530	615	712
Acetate Plastics	91	98	109
Photo Film	108	131	165
Ester-Ethers	119	138	155
Mixed Ester	20	21	22
Coatings	9	9	9
Triacetin	22	25	30
Aspirin	19	20	25
Other	36	40	43
Net Exports	(18)	(20)	(20)
Total Production	1526	1650	1812
Effective Capacity	1600	1600	1900
Capacity Required	(74)	50	(88)

HMDA is used almost entirely for nylon fiber and resin production. HMDA is used for nylon 6/6, 6/10, and 6/12. It is not used for production of nylon 6. Miscellaneous end uses for HMDA include polyurethane coatings, polyamide adhesives, ink resins, and specialty surface-active agents. Total HMDA output for these miscellaneous end uses amounts to less than 1% of HMDA production.

The outlook for HMDA is reflected in the summary table for U.S. fiber consumption - 1977, 1982, and 1987, adjusted for the nylon 6/nylon 6,6 split. The one-third nylon 6, two-thirds nylon 6,6 ratio is expected to continue.

Consumption of nylon is expected to increase to about 2,700 million pounds by 1982 and to about 3,200 million pounds by 1987.

The 1987 production level for nylon 6,6 will require about 1200 million pounds of HMDA. Present capacity is above that figure and therefore no H_2 capacity is expected for HMDA in the 1978-1987 period.

3.1.4.5.2 ADIPIC ACID/CAPROLACTAM

Adipic acid is presently produced by oxidation of cyclohexane. Potential new technology would involve carbonylation of butadiene.

Approximately 90% of adipic acid production is used for manufacture of nylon 6,6 products. This ratio is expected to continue over the 1978-1987 period.

The 1977 adipic acid production capacity was about 1,900 million pounds. This capacity is expected to be sufficient for nylon 6,6 and other requirements through the 1978-1987 period assuming no plant shutdowns.

Hydrogen is required indirectly for the production of adipic acid due to the use of cyclohexane. Cyclohexane is manufactured from benzene and hydrogen. Although cyclohexane is produced at U.S. refineries, not chemical companies, nearly all cyclohexane is consumed for chemicals production. Cyclohexane can also be used in the production of caprolactam. Approximately 50% of caprolactam capacity is based on cyclohexane.

The 1977 production rate of 1,100 million pounds for adipic acid and 800 million pounds for caprolactam were about 58% and 71% of nameplate capacity, respectively. As mentioned above, adipic capacity will be sufficient through 1987, barring shutdowns due to new technology. By 1982 caprolactam is expected to be at 80% of capacity. At the projected 1987 production rate for nylon 6, a 95% operating rate on nameplate would be required. A previously announced but cancelled caprolactam plant was sized at 250 million pounds. That is the assumed size for the plant required in the 1983-1987 period.

The present U.S. cyclohexane capacity of 3,100 million pounds will be adequate to cover the 1,800 million pounds required for adipic acid and caprolactam production in 1982. This capacity will also be adequate for the 2,575 million pounds of cyclohexane required for 1987 production of nylon 6 and nylon 6,6 assuming:

1. No technology changes.
2. A new caprolactam plant at 250 million pounds requiring 265 million pounds of cyclohexane with start-up in 1987.
3. Nylon 6 and 6,6 uses of cyclohexane continue at 90% of total cyclohexane use.

3.1.5 OTHER CHEMICALS

3.1.5.1 ACETIC ACID

Acetic acid is produced commercially in the U.S. using three different technologies. The technology chosen in recent capacity additions requires carbon monoxide and methanol as feedstocks. Methanol syngas requirements were covered in the methanol section of this study. This section defines future carbon monoxide requirements for acetic acid production.

Domestic and imported acetic acid production totaled about 2,600 million pounds in 1977. Imports amounted to about 1% of that figure. Acetic acid is co-produced in some chemical intermediate processes. These supply sources accounted for about 250 million pounds in 1977 for a total supply capability of 2,850 million pounds.

Market requirements in 1977 amounted to a sold out position. Over the period 1978-1982, two additional carbon monoxide-methanol based plants will come on stream. This will raise nameplate on-purpose capacity to over 4,000 million pounds and effective on-purpose capacity to over 3,800 million pounds. Market requirements are expected to grow at about 4.5% annually for the 1978-1987 period. By 1987 demand will require additional capacity. A continuation of the trend toward methanol carbonylation technology is assumed. This will require 12.5 MMSCF of carbon monoxide at the end of the 1983-1987 period.

Table 3.20 summarizes demand requirements, effective capacity, by-product acetic production, and requirements for additional on-purpose capacity.

Table 3.20

ACETIC ACID SUPPLY/DEMAND PROJECTIONS
(MM lbs.)

	1977	1982	1987
Acetic Anhydride	868	936	1020
Vinyl Acetate	1172	1464	2048
Terephthalic Acid	157	350	457
Alcohol Acetates	217	242	267
Textiles	69	62	55
m-Chloroacetic acid	66	32	36
Diketene	38	46	55
Acetate Sales	19	21	21
Organic Dyes	12	14	15
Pharmaceutical	14	17	19
Ethylene Glycol	3	33	34
Other	134	172	204
Total	2769	3889	4231
Effective Capacity	2566	3850	3850
By-Product	245	273	354
Capacity Required	0	0	525

3.1.5.2 PESTICIDES

Phosgene, produced from carbon monoxide and chlorine, is an important feedstock in the production of pesticides. It is estimated that approximately 10-11% of phosgene produced in the United States is used in pesticide production. The volume of phosgene produced for pesticide consumption for a recent year is shown below.

CONSUMPTION OF PHOSGENE IN PESTICIDES, 1977
(MM lbs.)

	Quantity
Insecticides	65
Herbicides	40
Fungicides	11
Total	116

Methyl isocyanate (MIC) produced from phosgene and methylamine, is the most utilized phosgene intermediate, accounting for 56% of the pesticide market for phosgene. Commercial success of carbamate pesticides based on MIC and other phosgene derivatives is mainly due to their environmental acceptance. The use of phosgene derivatives in pesticides is shown in Table 3.21.

3.1.5.2.1 INSECTICIDES

Carbamate insecticides are characterized by short to moderate activity with acute toxicity. Such insecticides work within the nervous system of the insect, causing eventual respiratory system failure. Carbamate insecticides find their greatest use in corn, soybean, alfalfa and cotton applications. Major products are listed in Table 3.23 with approximate capacities.

3.1.5.2.2 HERBICIDES

Phosgene is used in the production of both carbamate (and thiocarbamate) and urea herbicides which are produced from phosgene and anilines. Carbamate herbicides are most effective for corn applications, while ureas find uses predominantly on soybeans and cotton. Consumption growth of carbamate herbicides is projected at 2.6-4.4%/year, and urea at 3.3%/year. Major herbicide products are summarized in Table 3.24.

Table 3.21

PHOSGENE DERIVATIVE USAGE IN U.S. PESTICIDES, 1977
Million Pounds Phosgene

Intermediate	Quantity
MIC	65
Carbamyl chlorides, thiochloroformates	21
'In Situ' Isocyanates	12
Chloroformates	3
Isocyanates (phenyl and C_2-C_6 aliphatic)	10
Total	116

Monomethyl carbamate insecticides and pesticides, are produced by reacting methyl isocyanate with hydroxyl groups of phenol, oxime or hydroxy-substituted hetero cyclic compounds. The three most important mono-isocyanates are methyl, n-butyl and cyclohexyl. Methyl isocyanate accounts for about 90% of this production, as shown below.

Table 3.22

U.S. PRODUCTION OF MONOISOCYANATES
Million Pounds

	1976	1982	AAG 1976-82
Methyl Isocyanate	30.3	54.6	10.3%
n-Butyl Isocyanate	3.0	3.9	4.6
Cyclohexyl Isocyanate	1.1	3.8	23.0
Total	34.4	62.3	10.4%

Table 3.23

PHOSGENE - CONSUMING CARBAMATE INSECTICIDES

Location	Product Generic Name/ Trade Name	Capacity (MM lbs) 1977	1982
Gulf Coast			
	methonyl/Lamate	5	5
	oxamyl/Vydate	n.a.	n.a.
	BPMC/MIPC	n.a.	n.a.
Ohio Valley			
	thiofanox/Dacancox	--	n.a.
	oxamyl/Vydate(1)	1	--
	aldicarb/Temik(1)	4	6-10
	carbaryl/Sevin	72	100
Mid-Atlantic			
	carbofuran/Fudaran(1)	15	30
	BPMC, CPMC, MIPC	n.a.	n.a.
Other			
	bendrocarb/Fican, Garvox	1	1
	formetanate/Caryol	1	n.a.
	methonyl/Nudrin	2	2
	BPMC, CPMC, MIPC	2	5

(1) also used as fungicide and fumigant

3.1.5.2.3 FUNGICIDES AND FUMIGANTS

Dithiocarbamate fungicides and fumigants are also used as pesticides and are included in Table 3.24.

3.1.5.2.4 PROJECTED CO REQUIREMENTS

Table 3.25 summarizes projected CO use for phosgene manufacture in the insecticide, herbicide and fungicide markets.

3.1.5.3 POLYCARBONATES

Originally, polycarbonates were produced by a solution polymerization process in which the phosgenation reaction is carried out in a homogeneous solvent such as pryridine/methylene chloride. However, recent evidence suggests that all domestic producers are currently using interfacial polymerization of bisphenol A and phosgene to produce polycarbonates. Phosgene is produced on site from chlorine and carbon monoxide.

Polycarbonates are high performance thermoplastics with high optical clarity and impact strength. These thermoplastics have found application in glazing, lighting and equipment housings.

The high demand growth rates for polycarbonates experienced in the 1970's (13-15%) are expected to moderate somewhat in the future due to increasing competition from other plastics as well as approaching saturation in some markets. Demand growth can still be expected to grow at near ten percent per year. Growth at this level may attract new producers to the polycarbonate market.

Table 3.26 summarizes projected demand through 1987 for polycarbonates by end product. Throughout the period, demand growth is projected at 10%.

Capacities for polycarbonate production are shown in Table 3.26. Given these supplies, additional capacity is needed during each of the 1978-82, 1983-87 periods. One 150 million pound per year plant is projected for each of these periods. Additional CO requirements of about 900 MSCFD are projected for each five year period with one addition each in the Gulf Coast and Ohio Valley regions.

Table 3.24

PHOSGENE - CONSUMING HERBICIDES

Product and Location	Product Common Name/ Trade Name	Capacity (MM lbs) 1977	1982
Carbamate			
Gulf Coast	Butylate/Sutan EPTC/Eptam	50	60
Ohio Valley	chlorpropham/Furloe	7	7
	propham/Chemhoe	3	3
Mid-Atlantic	karbutilate/Tandex	n.a.	n.a.
Other	barban/Carbyne	n.a.	n.a.
Urea			
Gulf Coast	linuron/Lorox monuron/Telran siduron/Tupersan	30	30
	duiron	4	4
Mid-Atlantic	chloroxuron/Temoran	n.a.	n.a.
Other	chlorobromuron/Maloran	n.a.	n.a.

Table 3.25

PROJECTED CO USE IN PHOSGENE PRODUCTION (MM SCFD)

	1977	1982	1987
Insecticide	2.5	4.1	5.5
Herbicide	1.7	2.2	2.8
Fungicide	0.4	0.6	0.8
	4.6	6.9	9.1

Table 3.26

U.S. DEMAND FOR POLYCARBONATES
(MM lbs.)

	1977	1982	1987
Glazing	35	65	90
Lighting and Signs	7	11	20
Business Machines	22	40	55
Appliances	28	40	65
Transportation	21	30	55
Tools	14	20	30
Electric/Electronic	26	40	65
Sporting Goods and Helmets	8	10	15
Other	9	0	35
Total Consumption	170	266	430
Exports	11	17	30
Total U.S. Production	181	283	460
Effective Capacity	245	245	245
Capacity Required	(64)	38	215

3.1.5.4 HYDROGEN PEROXIDE

Hydrogen peroxide is currently produced by the successive hydrogenation and oxidation of ethylanthraquinone or other organic diketone.

Hydrogen peroxide has a wide market base but is used mostly as a bleaching agent. Its greatest market is in textile bleaching. It is also used in the paper industry to bleach wood pulp. Hydrogen peroxide is used in other paper making applications to de-ink recycled newsprint, a market which is expected to grow during the next decade. The chemical industry provides a market for hydrogen peroxide in the production of plasticizers, peroxides, and glycerol. Waste water treatment is expected to become a major market for hydrogen peroxide within the next few years. It can effectively remove hydrogen sulfide from sewer systems, as well as replace chlorine in prechlorination treatment of wastewater. Current uses for hydrogen peroxide are shown in Table 3.27.

During the 1970's, growth for hydrogen peroxide has averaged 6.5% per year. New uses in wastewater and paper bleaching applications are expected to assure steady, consistent growth over the next decade at a 5-6% rate.

There are currently four domestic manufacturers of hydrogen peroxide, with a fifth expected to enter the market before 1980. The price of hydrogen peroxide over the past ten years has been depressed due to the building of new plants utilizing more efficient and less costly product which resulted in overcapacity. Not until 1978 did the price reapproach the 1969 level. Two expansions are expected in the 1978-1982 period. A total hydrogen requirement of 5.4 MMSCFD is expected.

Table 3.27

U.S. DEMAND FOR HYDROGEN PEROXIDE
(MM lbs.)

	1977	1982	1987
Textile Bleaching	59	82	95
Plasticizers and Epoxidation	51	72	90
Glycerine Production	18	20	22
Pulp and Paper Bleaching	16	26	39
Water Treatment	13	26	40
Miscellaneous	18	23	29
Exports	19	26	35
Total	200	275	350
Effective Capacity	275	425	425
Capacity Required	0	150	0

3.1.5.5 1,4 BUTANEDIOL

1,4-butanediol is produced domestically by reacting acetylene with formaldehyde to produce 1,4-butynediol which is subsequently hydrogenated to 1,4-butanediol. The final product is used to produce tetrahydrofuran (a specialty solvent) and several acetylinic chemicals and polymers. The major acetylinic chemicals produced from the diol are used in a number of adhesives, pharmaceuticals and solvents. The recent development of markets for 1,4-butanediol in the production of polybutylene terepthalate (PBT) and polyurethanes will provide much of the demand growth in future years. PBT is a polymer substitute for metals and thermoset resins. Both PBT and polyurethanes (especially reaction injection molded polyurethanes) are expected to find a significant market in automobile applications. Current and projected demand for 1,4-butanediol is shown in Table 3.28.

The domestic demand for 1,4-butanediol is expected to grow at greater than 9% per year through 1981 and nearly 8% from 1981 to 1986. The resulting total demand is shown on Table 3.28 along with domestic production capacity and supply.

3.1.5.6 SPECIALTY CHEMICALS

A number of chemical synthesis technologies require relatively small quantities of H_2, CO, or syngas. The small requirements for H_2 and/or CO may be due to either a small market for the chemical produced or small proportions of H_2 and CO in the chemical product. These small H_2 and CO consumers are grouped in this section on specialty chemicals.

Some technologies which require H_2 or CO are obsolete as far as new capacity expansions are concerned even though existing plants may continue to operate. These situations are discussed briefly.

Brief product application descriptions are given and where significant, market and plant capacity statistics are discussed in the following paragraphs.

Table 3.28

U.S. DEMAND FOR 1,4-BUTANEDIOL
(MM lbs.)

	1977	1982	1987
Tetrahydrofuran (THF)	107	133	167
Acetylinic Chemicals	50	79	126
Polyurethanes			
Thermoplastic Polyurethane	11	14	18
Castable Polyurethane	5	5	6
Rim Injection Molded (RIM) Polyurethane	4	14	26
Polybutylene Terephthalate (PBT)	19	44	65
Miscellaneous	4	11	22
Total	200	300	430
Effective Capacity	338	338	414
Surplus/(Deficit)	128	38	(16)

3.1.5.6.1 SPECIFIC SPECIALTY CHEMICALS

The fatty acid industry developed around the process of upgrading tallow and lard into soap manufacturing. Splitting and distillation techniques were rapidly introduced during World War II for the purpose of recovering glycerin to be used in explosives. The markets for fatty acids today are dependent on cosmetics and toiletries (including bar soap), other cleaning products and synthetic lubricants. The other major branch of alkali refining of oils, the edible products markets, are not considered chemicals and are not discussed in this section.

Fatty acids are generally considered to be those monocarboxylic acids higher than the straight-chain (C_1-C_4) carboxylic acids (formic, acetic, propionic, butyric).

Beginning in 1980, hydroformylation technology will be first used in the U.S. to produce the first synthetic acids in the C_5-C_{10} medium length range. The C_{11}-C_{15} coconut range acids are expected to continue to involve the sequence of operations involved in processing coconut oil, the most common feedstock: 1) fat splitting, 2) distillation, and 3) hydrogenation.

During the period 1978-1987, the demand for medium length fatty acids is expected to increase from somewhat over 100 million pounds to about 175 million pounds. The new synthetic acid plant should be the only expansion required in the 1978-1987 period and will require about 4.5 MMSCFD syngas. Existing production capacity for coconut-range acids is expected to be sufficient through 1987.

MMT, a tricarbonyl, was introduced in 1974 as an economical octane source for unleaded gasolines. Discussions concerning the impact of MMT on air quality followed and today only minor amounts of MMT are used in the U.S. gasoline pool. Some MMT is exported. No future capacity expansion is expected.

Dimethylformamide is an industrial solvent used in butadiene and isoprene manufacture as is acetate-fiber spinning. Demand is expected to increase by more than 50% during the 1978-1987 period. Existing U.S. capacity to produce DMF, including carbon monoxide generating capacity, is expected to be sufficient to meet increased demand throughout the 1978-1987 period.

Methyl formate is a chemical intermediate used in the manufacture of dimethyl formides (acrylic fibers), esters, aldehydes, and other intermediates. It is produced from carbon monoxide and methanol. Future methyl formate capacity expansions are not expected to require carbon monoxide capacity expansions at existing methyl formate production locations.

Oxalic acid is formed from sodium hydroxide and carbon monoxide via sodium formate. The acid is used primarily in textile and metal cleaning but is also sold as a chemical intermediate. The market outlook for oxalic acid is stagnant, with consumption holding steady at 20 MM lb/yr. The sole domestic producer operates two plants for the production of oxalic acid, but has sufficient capacity at one location to supply the United States. Both plants are located in the Northeast U.S.

Glycolic acid is used in the leather industry and in preparing chelating formulations of iron. The sole domestic producer, located in the Ohio Valley region, manufactures this acid via the reaction of formaldehyde and carbon monoxide. Excess carbon monoxide production capacity at that location is expected to be sufficient for any glycolic acid expansions during the period 1978-1987.

Sorbitol is a sweetening agent which has been used extensively in recent years, especially in the sugarless candy and chewing gum markets. It is also widely used as an intermediate in the production of vitamin C. Sorbitol is naturally occurring in many foods, but is prepared commercially through the catalytic hydrogenation of sugars. The sweetener is usually sold in liquid form, as a 70% solution in water.

The market for sorbitol has been increasing at about 5% annually for the past several decades, with several years showing growth at greater than 9% p.a. during the 1970's. However, with growth expected to moderate in the early 1980's, expansions by leading producers over the past few years assure an adequate supply throughout the next ten years. No further expansions are planned nor expected.

Furfuryl alcohol is produced by moderate to high pressure hydrogenation of furfural over a copper chromate catalyst. The alcohol can be further hydrogenated to tetrahydrofuryl alcohol. Furfuryl alcohol is the major derivative of furfural. It is used in producing furan resins for foundry binders and metal castings and cores. There is only one U.S. manufacturer currently producing furfuryl alcohol. Since the feedstock for the alcohol is furfural which is produced from agricultural feedstocks, plants are located in agricultural regions. Estimated capacity is nearly 100 million pounds. Production in 1977 was about 50 million pounds and no capacity expansions are expected during the 1978-1987 period.

Tetrahydrofuran is usually produced from butanediol, however, one manufacturer in the United States currently produces THF through the catalytic hydrogenation of furfural. No expansions are expected via this technology during the 1978-1987 period.

Cyclohexylamine is produced by the hydrogenation of aniline. It is used as an intermediate in the production of several rubber chemicals and as a carbon dioxide scavenger in boiler systems. Small amounts are used in the production of cyclamate sweeteners. Production capacity is located in the mid-Atlantic region and also in the Western U.S. A 1978-1982 expansion is expected at the Western U.S. location and another is expected on the Gulf Coast in the 1983-1987 period.

3.1.5.6.2 H_2/CO REQUIREMENTS

The estimated H_2 and CO capacity additions required for production of specialty chemicals is as follows (MMSCFD):

	1978-82	1982-87
H_2	2.5	0.3
CO	2.2	--

3.1.6 ELECTROLYTIC HYDROGEN POTENTIAL IN CHEMICAL MANUFACTURE

As proposed, one element of this study concerns the potential for production of hydrogen for chemical manufacture in the mid-Atlantic region using electrolytic cells.

This evaluation assumes that cell hydrogen is economically competitive when produced in volumes of from 200,000 SCFD to 500,000 SCFD. As defined in Table 3.1, Section 3.1 of this study, no potential hydrogen markets were identified for the mid-Atlantic region in this size range during the 1978-1987 period. This conclusion is no doubt due to the fact that hydrogen uses in this volume range are concentrated in non-chemical applications such as metal treating, edible oil processing, float glass plants, and electronics manufacture.

Because market conditions in the mid-Atlantic area do not warrant further study, no electrolytic hydrogen economics will be considered in this study.