NITROGEN

By Raymond L. Cantrell

In 1994, nitrogen compound supplies in the United States reached an all time record high because of strong domestic demand for agricultural and industrial products; an extremely tight supply situation was experienced. The total value of the U.S. nitrogen compound supply, f.o.b. U.S. Gulf, nearly doubled to an impressive $5.0 billion, compared with $2.7 billion during the previous year.

A unique combination of strong upward movement in the domestic nitrogen market led to several new all time record highs, including nitrogen fertilizer consumption[1] and agricultural exports.[2] Record quantities of imported ammonia were required to meet heavy demand. Ammonium phosphate export shipments to China more than doubled to a record high 5.4 million metric tons, adding substantially to ammonia demand. A strong performance by the industrial sector further contributed to extremely tight supplies and upward price pressure. Profitability was enhanced by reasonably priced natural gas feedstock for ammonia production,[3] industry consolidation, and a favorable balance between supply and demand in the global fertilizer and grain sectors.[4]

Legislation and Government Programs

The President signed the Uruguay Round GATT Agreements Act, H.R. 5110—Public Law No. 103-465—on December 8, 1994. The new multilateral General Agreement on Tariffs and Trade was expected to gradually result in the lowering of global tariff barriers, thus improving the prospects for improved access of U.S. agricultural exports to major countries around the globe.[5]

Section 313 of the Environmental Protection Agency's (EPA) Emergency Planning and Community Right-to-Know Act of 1986 (Public Law 99-499) required EPA to establish a national inventory of toxic chemical emissions from certain facilitates, called the Toxics Release Inventory (TRI). EPA's 1992 TRI published in April 1994,
revealed that ammonia ranked first in terms of total releases, and second in terms of direct releases to the air, water, and land. Ammonia ranked first in terms of underground injection, second in discharges to surface water, and third in terms of the largest emissions to the air. Ammonium nitrate solution, nitric acid, acetonitrile, and ammonium sulfate solution were also listed in the top 50 TRI releases, in order of importance.[6]

Production

U.S. ammonia producers operated at more than 100% of design capacity in 1994. Ammonia ranked as the sixth largest volume chemical produced in the United States, according to information published by Chemical and Engineering News in April 1995. Approximately 87% of domestic production was for fertilizers, and 13% for industrial use. Urea, ammonium nitrate, ammonium phosphates, ammonium sulfate, and nitric acid for direct use, were the major downstream products produced from ammonia in the United States, in order of importance.

Sixty percent of total U.S. ammonia production capacity was concentrated in the States of Louisiana (40%), Oklahoma (14%), and Texas (6%), owing to large indigenous reserves of natural gas feedstock. Plants in several midwestern States accounted for another 16% of the total; with the remainder equally divided between the southern and southeastern States, and western States (12% each). Farmland Industries, Inc.; Arcadian Corp.; Terra International, Inc.; CF Industries, Inc.; and Union Chemical Co. (Unocal) accounted for 46% of total U.S. ammonia capacity, in order of importance *(See tables 1, 2, 3, and 4.)*

In mid-1994, Mississippi Chemical Corp. (MCC) of Yazoo City, MS, went public on the NASDAQ exchange. The firm had formerly operated under a private farm cooperative system. The new structure was designed to provide working capital needed for expansion. In mid-September 1994, MCC and Air Products & Chemicals, Inc., finalized an agreement whereby MCC would purchase Air Products' annual ammonium nitrate output of 240,000 tons at Pace Junction, FL, for resale over a period of 15 years. MCC was to transfer its proprietary AMTRATE ammonium nitrate technology to Air Products.

Dakota Gasification Co. of Beulah, ND, announced the construction of a 300,000-ton-per-year ammonia plant based on methane gas feedstock derived from lignite. A used ammonia plant was to be moved from Freeport-McMoRan's idle Fort Madison, IA, facility. Total ammonia capacity, including that already onsite, should approximate 310,000 tons per year. The first flue gas desulfurization unit based on ammoniation of sulfur dioxide to produce salable ammonium sulfate, was to be constructed using General Electric Environmental Systems' Inc. technology. The unit was designed to produce 180,000 tons per year of salable ammonium sulfate, to be marketed under contract by H. J. Baker and Bros. The project was scheduled to come on-stream in late-1996.

Terra Industries, Inc., purchased the Agricultural Minerals Corp. (AMC) nitrogen fertilizer facilities at Verdigris, OK, and Blytheville, AR, having a combined annual ammonia capacity of 1.3 million tons, and about 1.0 million tons of urea. The $400 million transaction, included about 300 million gallons of annual methanol capacity, which was to continue to be handled by the former AMC subsidiary, Beaumont Chemical Corp.

In mid-December 1994, Terra's ammonium nitrate plant near Sioux City, IA, was destroyed, and the ammonia plant damaged, when a blast occurred in the ammonium nitrate neutralizer section. Terra officials estimated that the ammonia plant would be out of service for about 1 year, while plans were formulated to rebuild the nitrogen solutions and ammonium nitrate section at a later date.

LaRoche Industries, Inc., negotiated a joint-venture agreement to purchase a 50% interest in Cytec Industries' 400,000-ton-per-year ammonia plant at Fortier, LA, to be called Avondale Ammonia. LaRoche was to consume its share of the ammonia for fertilizer and industrial applications, while Cytec's applications were primarily for industrial purposes.

LaRoche was also upgrading and doubling the capacity of two nitric acid plants at Cherokee, AL, and adding 50,000 tons per year to ammonium nitrate capacity, in a $5 million project scheduled for completion by the fall of 1996. Nitrogen oxide emissions were to be reduced by 30%.

Arcadian Corp. was upgrading nitrogen production facilities at Augusta, GA, and

Memphis, TN. The $16 million project was designed to improve energy efficiency and add incrementally to ammonia and nitrogen solutions capacity. The firm also planned a $78 million expansion project that, in aggregate, would increase urea and ammonia synthesis capacity at Memphis, TN; relocate its idle nitric acid and ammonium nitrate facility at Savannah, GA, to Lima, OH, for nitrogen solutions production, along with an ammonia plant retrofit at Clinton, IA, designed to reduce energy consumption.

Arcadian contracted IDM Environmental Corp. to dismantle and relocate an idle 140,000-ton-per-year nitric acid plant at Gibbstown, NJ, purchased in December 1993 from E.I. du Pont de Nemours & Co., to its facility at Geismar, LA. The plant was to provide product for industrial sales by early 1996. IDM was also dismantling Arcadian's idle ammonia plant at Lake Charles, LA, for shipment to Karachi, Pakistan.

Arcadian purchased an idle ammonia plant at Brea, CA, from Louisiana Chemical Equipment, that was closed by Unocal Corp. in 1989. The 250,000-ton-per-year plant was to be dismantled and moved to Arcadian's nitrogen and urea facility at Point Lisas, Trinidad.

Vigoro Corp.'s subsidiary Phoenix Chemical Co. increased ammonia capacity at East Dubuque, IL, by 4% to 260,000 tons per year in a cost effective retrofit that lowered energy consumption from 36 to 35 million Btu's per ton of ammonia.

Chevron Chemical Co. announced that its nitric acid and nitrogen solutions plant at Richmond, CA, would be permanently closed by mid-1995. Unocal was operating the 100,000-ton-per-year nitric acid plant and 200,000-ton-per-year liquid fertilizer plant under the provisions of a 5-year tolling agreement, and reportedly, had the right of first refusal to buy the plant, dismantle, and move it to another location. Ocelot Ammonia Co. of Kitimat, British Columbia, was reportedly entertaining offers for the plant because of its improved market potential on the West Coast.

El Dorado Chemical Co. was reconstructing a nitric acid facility purchased from the U.S. Army's ammunition production facility at Joliet, IL. The $12 million project was to increase nitric acid capacity at the firm's El Dorado, AR, by about 35% to 480,000 tons per year by early 1995. El Dorado produced fertilizer and industrial grade ammonium nitrate, and concentrated nitric acid for the industrial merchant market.

Apache Nitrogen Products, Inc., contracted Jacobs Engineering Group Inc. to reactivate a wholly owned nitric acid plant at St. David, AZ, that had been idle for 10 years. Capacity was increased 50% to 140,000 tons per year at the time of commissioning in May 1994.

Olin Corp. announced an expansion of its 150,000-ton-per-year nitric acid facility at Lake Charles, LA, to accommodate new toluene diisocyanate (TDI) capacity that was for polyurethane production.

Consumption

Finished nitrogen products produced from ammonia in the United States were allocated about 80% to fertilizers and 20% to the industrial sector. Urea was used as a direct application fertilizer and as a component in the popular urea-ammonium nitrate (UAN) fertilizer solutions containing 28% to 32% nitrogen (N). In the industrial sector, urea was used extensively as a protein supplement in ruminant animal feeds; for the production of urea-formaldehyde adhesives and for the synthesis of melamine plastics and resins.

Ammonium phosphate compounds were consumed principally as fertilizers for domestic consumption and export, although high purity materials found popular use as the active ingredient in fire extinguishers, and bulk agricultural grade materials were used as fire retardants for forest fires and other purposes.

Ammonium nitrate was used in solid and liquid fertilizers, and in industrial explosives and blasting agents most commonly prepared as ammonium nitrate-fuel oil solid mixtures (ANFO), and also in slurry and gel forms. Ammonium sulfate was used primarily as a fertilizer material, resulting predominately as a reaction by-product of caprolactam, the monomer for Nylon-6 fiber and plastics.

Nitric acid was used directly for myriad uses, including salt formation reactions to produce metal nitrates, and in metal degreasing, treating and pickling for the graphic and galvanic industries. Nitration reactions with benzene, toluene, and phenol, produce dyestuffs, pharmaceutical products, trinitrotoluene (TNT) explosives, and disinfectants, respectively. Esterification reactions with glycol, glycerol, and cellulose, produce nitroglycerine explosives (dynamite), celluloid and nitrocellulose lacquers. Oxidation reactions with toluene, p-xylene, and cyclohexanone, produce polyurethanes, polyester fibers and plastics, and polyamide fibers and plastics (Nylon), respectively.

Acrylonitrile is produced from propylene and ammonia, for acrylic fibers, high impact acrylonitrile-butadiene-styrene (ABS) plastics, and nitrile elastomers.

Ammonia is used to produce hydroxylamine sulfate, to synthesize cyclohexanone oxime, for caprolactam production, through the Beckman Rearrangement reaction. Depending upon the process, the by-product ammonium sulfate:caprolactam weight ratio ranges between 2:1 to 4:1. *(See table 5.)*

Other uses of ammonia are for the production of amines, cyanides, and methyl methacrylate polymers (plexiglass); liquid home cleaners, pulp and paper production, industrial refrigeration, and metallurgy.

U.S. nitrogen fertilizer applied for domestic consumption was up 12% to a record 11.5 million tons N in 1994. Consumption was up substantially owing to a significant increase in feedgrain acreage and the need to replenish nutrient deficient soils resulting from record summer flooding during the 1993 fertilizer year. Direct application anhydrous ammonia exhibited the largest increase. *(See table 6.)*

Net farm income in 1994 was estimated at $49.7 billion by the U.S. Department of Agriculture, compared with $43.4 billion in 1993. Net outlays for farm programs in 1994 was $10.3 billion.[7]

Stocks

U.S. producer stocks of nitrogen compounds in all identifiable forms were up by a moderate 3% between 1993 and 1994. *(See table 7.)*

Transportation

Ammonia was transported by refrigerated barge, rail, pipeline, and truck. Koch Industries operated the Gulf Central Ammonia Pipeline that extended about 3,060 kilometers (km)—1,900 miles—from the Gulf of Mexico into the Midwest, as far north as Iowa. The annual capacity of this pipeline was about 2 million tons, with storage capacity of more than 1 million tons.

Mapco Ammonia Pipeline Inc. operated Mapco Ammonia Pipeline and its sister company, Mid-America Pipeline, along a 1,770 km—1,098 mile—corridor that extended in a northeasterly direction from Borger, TX, in northern Texas, to Mankato, MN, in southern Minnesota. The Mapco pipeline had an annual capacity of about 1 million tons and about 500,000 tons of ammonia storage capacity.

CF Industries, Inc., and Cargill Fertilizer, Inc., were operating the Tampa Bay Pipeline system, a joint-venture ammonia pipeline that serves nitrogen compound and ammonium phosphate producers in Hillsborough and Polk Counties, FL.

Prices

Ammonia prices, f.o.b. barge, New Orleans, rose dramatically during January-June 1994,

from about $140 per ton in early January, to an average of near $190 for the 6-month period. Prices rose even further during July-December, and at yearend were running about $245 per ton. Granular urea prices, f.o.b. U.S. Gulf, were relatively flat during the January-June period, but moved up substantially during the second-half of the year, and closed at a robust $220 per ton. UAN and ammonium nitrate prices also trended upwards as the year progressed. Diammonium phosphate prices were quoted at $190 per ton, f.o.b. central Florida, at yearend 1994, representing an increase of more than 20% compared with the same period in 1993. Ammonia and diammonium phosphate futures prices quoted on the Chicago Board of Trade (CBOT) reflected a firm price trend well into 1995. *(See table 8.)*

Foreign Trade

U.S. ammonia imports reached a record high 4.2 million product tons in 1994, and averaged about $173 per ton, c.i.f., compared with $128 per ton during the prior year. Ammonia exports were down substantially owing principally to the tight supply-demand situation. Trinidad and Tobago, Canada, Russia and the Ukraine, and Mexico, in order of importance, supplied about 90% of total U.S. ammonia import tonnage. *(See tables 9 and 10.)*

Ammonium phosphate exports were up 2.3 million tons, or 28% between 1993 and 1994, owing principally to a record imports by China. U.S. nitrogen product exports, in total, increased by 2.6 million tons, or 24% above 1993 levels.

U.S. nitrogen product imports in 1994 were up 1.5 million tons, or 18% compared with 1993 levels. Of this total, ammonia imports accounted for about 65% of the increase. There was a general increase in all major nitrogen imports between 1993 and 1994. The average c.i.f. price for all nitrogen imports averaged about $157 per ton in 1994 compared with $137 during the prior year. *(See tables 11 and 12.)*

World Review

Global ammonia production in 1994 increased 3% relative to 1993 levels, according to information reported by the International Fertilizer Industry Association (IFA), Paris, France. Total ammonia production was about 91.6 million metric tons N in 1994, based on data reported by the U.S. Bureau of Mines. Production increased in most regions except for the former U.S.S.R., where Russia and the Ukraine continued in a downward spiral established since the dissolution of the U.S.S.R. *(See table 13.)*

Geographically, about 40% of global ammonia production originated in the Far East, where China accounted for 55% of the regional total. North America—the United States and Canada—was 18% of the global total, with the United States accounting for 80% of the region. Countries in the former U.S.S.R. were 13% of the total; Western Europe, 11%; Latin America and the Middle East, 6% each; Eastern Europe, 5%; and Africa and Oceania, about 1% each.

Ammonia exports were up 11% to 10 million tons N between 1993 and 1994, with Russia and the Ukraine, Trinidad and Tobago, Canada, and Mexico accounting for more than 60% of the total, in order of importance. Several countries in Western Europe and the Middle East shipped most of the remainder. The United States imported 36% of global ammonia trade, followed by several countries in Western Europe (34%) and the Far East (15%). The remainder was imported by several countries in other regions around the globe.

Global urea production was 37.6 million tons N in 1994, or 3% above 1993 levels, and represented about 40% of world ammonia N production. Approximately 52% of world urea production was from the Far East, with China, India, Indonesia, Pakistan, and Bangladesh dominating regional production, in order of importance. North American production was 13% of the total, with the United States accounting for about 70% of the region; the Middle East, 10%; the former U.S.S.R.—principally Russia and the Ukraine—9%; Western Europe, 6%; Eastern Europe and Latin America, 5% each; with Africa and Oceania accounting for the remainder.

World urea trade rose 7% to 10 million tons N between 1993 and 1994. Russia and the Ukraine, in combination, accounted for 25% of total shipments, while the former U.S.S.R., in total, was 27% of global urea trade. Saudi Arabia, Qatar, and several other countries in the Middle East shipped 22% of the total; Canada and the United States, 13%; Indonesia and other countries in the Far East, 12%; Western Europe, 10%; Eastern Europe, 9%; and Latin America, 6%. Africa and Oceania shipped minor tonnages.

China, the United States, India, and Vietnam, accounted for 51% of global urea imports, in order of importance. Urea imports in Western Europe were up 48% compared with 1993 levels, owing to large volume increases in France, Germany, Italy, and Spain. Urea imports in the Middle East were off by 63% owing to major declines in Syria and Turkey. On a regional basis, countries in the Far East accounted for 48% of global urea imports, North America and Western Europe, 15% each; Latin America, 11%; Oceania, 3%; Africa and the Middle East, 2% each; with Eastern Europe and unidentified locations accounting for the remainder.

***Canada.*—**High international prices for ammonia and low prices for Canadian natural gas generated renewed interest in reactivating an idle ammonia plant and debottlenecking three others. Ammonia N capacity was to increase by 500,000 tons per year.

***Far East.*—China.—**Fifteen ammonia-urea projects totaling 4 million tons per year N have been identified as either under construction, contracted, or planned in several provinces. Of this number, 11 complexes (3 million tons N) were expected to be commissioned during the next 5 years. Many new ammonia plants were to use coal or heavy fuel-oil as feedstock and fuel. The reduction or removal of subsidies on coal production and transportation have been announced.

A 330,000-ton-per-year ammonia and matching urea plant were expected to be commissioned in 1996 on Hainan Island. The Hainan complex should logically supply China, but logistical factors may favor exports. Large natural gas reserves have been identified offshore near Hainan Island; thus, additional plants could be built in the future, even though most will reportedly be used for power generation in South China and in the Hong Kong area.

Presently, China relies heavily on inefficient ammonium bicarbonate for its nitrogen supply (7.9 million tons N in 1993). World Bank analysts estimate that up to 40% of the ammonium bicarbonate N is lost to the atmosphere during handling and application. Production is costly and relies exclusively on anthracite feedstock that is produced in only two Chinese provinces. Consequently, ammonium bicarbonate production may be cut back when new capacity comes onstream.

India.—Urea imports in 1994 reached a record 1.3 million tons N. Two new plants were commissioned in 1994, and a third plant should be completed in 1995. Another five new ammonia-urea projects totaling 1.1 million tons per year of urea N were scheduled for completion by 1998. The plants will be equally divided between natural gas and naphtha feedstocks, in spite of persisting gas curtailments and uncertainties concerning future gas policy. Modernization of existing plants run by the Fertilizer Corp. of India and by Hindustan Fertilizer Corp. also have been announced.

New urea production capability may grow faster than demand, and as a consequence, urea imports could potentially decline in the next

few years. The future fertilizer policy in India remains uncertain, however, as the present urea subsidy program could change pending the outcome of the 1996 elections.

Indonesia.—Ammonia and urea surplus availability for export should be increased in 1995 owing to the recent commissioning of two new plants. The Indonesian Government has approved another two new ammonia-urea projects that are to be built during the next 4 years at Cikampek, Java, and at Lhok Seumawe, Sumatra, together with a new urea plant at Bontang, Kalimantan. These new plants are planned to be commissioned by 1998.

Pakistan.—Natural gas supplies have been allocated for the expansion of annual urea capacity by 0.7 million tons N in three new plants by 1998. Pakistan should begin to export small tonnages of urea in 1995, and by 1998, should have a significant surplus available for export.

Thailand.—Construction was scheduled to commence on a 0.2 million-ton-per-year urea N plant at Rayong. This was to be the world's first urea complex based on imported ammonia. Carbon dioxide feedstock was to be sourced from a natural gas field. An ammonia terminal was under construction to supply this plant, a mixed fertilizer facility, and a caprolactam plant, all to be built in the Rayong vicinity. An ammonia plant was planned in the more distant future.

Vietnam.—Urea imports continued to increase and, in 1994, were 0.8 million tons N, or 25% above 1993 levels. Domestic production is currently limited to a 1962 Chinese design medium scale ammonia-urea complex using anthracite as feedstock and fuel, in Northern Vietnam. An expansion of this facility was under consideration in spite of its obsolete technology and high costs.

In addition to associated gas that is currently flared, significant gas resources have been identified in the off-shore Bach Ho field and perhaps in other fields off the coast of Southern Vietnam. Consequently, it has been proposed that a joint project should be built on the southern coast at Vung Tau, involving a natural gas fired powerplant in which feedstock would be valued at $3 per million Btu, together with a 330,000-ton-per-year ammonia and 580,000-ton-per-year urea plant that would be charged $1.50 per million Btu for feedstock.

Former U.S.S.R.—The region continued as the world's leading exporter of ammonia and urea in 1994. Most of the product was produced in Russia and the Ukraine, in order of importance. Ammonia exports were 4.2 million tons product, and urea, 5.8 million tons product. These tonnages were about the same as in 1993.

In Russia, ammonia plants ran at 59% of capacity and urea plants at a rate of 69%. In Ukraine, ammonia and urea operating rates were 64% and 83%, respectively. About 75% of ammonia exports were from Russia, 20% from the Ukraine, with the remainder coming from Byelorussia and the Baltic states. About 70% was shipped from the Black Sea port at Yuzhnyy, Ukraine, and 30% from the Baltic port at Ventspills, Latvia. Ammonia exports were expected to be up about 15% to 5 million tons product in 1995.

Russia accounted for 55% of urea exports, the Ukraine, 40%; with Belarus, Uzbekistan, and the Baltic Republics accounting for the remainder. Exports through Yuzhnyy were 65% of the total. Urea exports were expected to be up between 5% and 20% in 1995.

The cost of natural gas continued to increase in both Russia and the Ukraine. In mid-1995, gas costs approximated $0.92 per million Btu in Russia and $1.90 per million Btu in Ukraine. For comparison, gas costs a year ago in Russia and the Ukraine were approximately $0.65 and $1.50, respectively. Growing involvement of the Russian gas company GAZPROM in the fertilizer industry, has improved the stability of gas supplies and of prices. In the Ukraine, the availability of natural gas was much improved, and price reductions were expected to be announced in the near future.

***Latin America.*—Argentina.—**A 0.3-million-ton-per-year N ammonia-urea project was planned in Neuquen province during the next 5 years.

Trinidad and Tobago.—Farmland Industries, Inc., and Mississippi Chemical Corp. contracted the M. W. Kellogg Co. of Houston, TX, to construct the largest single train ammonia plant in the world. The 600,000-ton-per-year, $300 million facility was to use Kellogg's new gas efficient Advanced Ammonia Process (KAAP), and was scheduled on-stream in late-1997.

Arcadian Corp. was adding 300,000 tons per year of ammonia capacity at its Point Lisas complex by 1996, based on the relocation of a plant from the United States.

Middle East.—The only firm ammonia-urea project at present was in Qatar where 0.4 million tons N was scheduled onstream in early-1997. Bids have been requested for a 0.9 million ton N ammonia-urea project in Oman.

Western Europe.—France, Italy, the Netherlands, and Spain each closed an ammonia plant in 1994. An idle plant at Thessaloniki, Greece, was recommissioned.

Current Research and Technology

Personnel at the U.S. Bureau of Mines Pittsburgh Research Center were studying methods of desensitizing ammonium nitrate to detonation. One objective is to determine a diluent and a level of dilution that minimizes the usefulness of ammonium nitrate as an explosive while retaining its benefit as a fertilizer. The Bureau has found that ammonium nitrate containing 20% urea will not detonate based on the simple addition of fuel oil.[8]

Various additives have been proposed to desensitize ammonium nitrate to detonation, including the production of calcium ammonium nitrate, a mixture containing 78.5% ammonium nitrate and 21.5% calcium carbonate in the form of dolomitic limestone, and used in Ireland and several other European countries as a counter-terrorist measure. About 30 years ago, Samuel J. Porter, a hazardous chemicals consultant from Woodbridge, VA, was awarded a patent claiming that the addition of 5% to 10% by weight of diammonium or monoammonium phosphate will prevent ammonium nitrate fertilizer from exploding.

Independent testing of ammonium phosphate and calcium carbonate additives by the consulting firm, Failure Analysis Associates of Menlo Park, CA, however, revealed that none of the materials eliminated the explosiveness of ammonium nitrate. Furthermore, thermodynamic data published by Mr. Peter G. Urben, editor of "Bretherick's Handbook of Reactive Chemical Hazards," show that heat released from the detonation of a mixture of ammonium nitrate and ammonium phosphate is up to 60% greater than that from ammonium nitrate alone. Ammonium sulfate additives give similar results.[9]

Outlook

Global supply-demand balances developed by IFA in May 1995, suggest that surplus ammonia availability may tighten sharply, from 4% of supply capability in 1995 (4 million tons N) to less than 1% (1 million ton N surplus) by 1999. The global urea supply-demand situation was forecast to remain in balance, and to become tighter with time, declining from 4% of supply capability in 1995 (1.5 million tons N), to about 3% by 1999 (1.3 million tons N).[10]

IFA's forecast was based on the most probable scenario at the time, which suggested a persistence of low operating rates in the former U.S.S.R. and Eastern Europe, owing to a multiplicity of downside factors, along with a decline in ammonium bicarbonate production in China, that would favor a gradual increase in

Chinese urea imports.

Significant ammonia and urea surpluses could develop at the global level, if operating levels in the former U.S.S.R. gradually improve during the forecast period, and China were to continue to produce large quantities of ammonium bicarbonate. Also, overreaction to significantly higher straight nitrogen compound, and ammonium phosphate prices in 1994, could precipitate a new round of global N capacity expansion that may accentuate oversupply.

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TABLE 1
SALIENT AMMONIA STATISTICS 1/ 2/

(Thousand metric tons of contained nitrogen unless otherwise specified)

	1990	1991	1992	1993	1994 p/
United States:					
Production	12,700	12,800	13,400 r/	12,600 r/	13,400
Exports	482	580	354	378	215
Imports for consumption	2,670	2,740	2,690	2,660	3,450
Consumption, apparent 3/	14,900	14,800	15,600 r/	15,100 r/	16,500
Stocks, Dec. 31: Producers'	797	936	1,060	852 r/	956
Average annual price per ton product, f.o.b. gulf coast 4/	$106	$117	$106	$121	$211
Net import reliance 5/ as a percent of apparent consumption	15	14	14	17 r/	19
Natural gas price: Wellhead 6/	$1.71	$1.64	$1.74	$2.03 r/	$1.83
World:					
Production	97,500 r/	93,800 r/	93,600 r/	91,700 r/	91,600 e/
Trade 7/	10,000	9,590	9,270 r/	8,990 r/	10,000

e/ Estimated. p/ Preliminary. r/ Revised.
1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits, except prices.
2/ Synthetic anhydrous ammonia, calendar year data, Bureau of the Census; excludes coke oven byproduct.
3/ Calculated from production, plus imports minus exports, and industry stock changes.
4/ Green Markets, Fertilizer Market Intelligence Weekly, Pike & Fischer, Inc.
5/ Defined as imports minus exports, adjusted for industry stock changes.
6/ Monthly Energy Review, U.S. Department of Energy. Average annual cost at wellhead in dollars per thousand cubic feet.
7/ International Fertilizer Industry Association statistics--World Anhydrous Ammonia Trade.

TABLE 2
FIXED NITROGEN PRODUCTION IN THE UNITED STATES 1/

(Thousand metric tons of contained nitrogen)

	1990	1991	1992	1993	1994 p/
Anhydrous ammonia, synthetic: 2/					
Fertilizer	11,600	11,600	12,000 r/	11,300 r/	11,600
Nonfertilizer	1,110	1,240	1,350	1,320 r/	1,750
Total	12,700	12,800	13,400 r/	12,600 r/	13,400
Byproduct ammonia, coke plants: 3/					
Ammonium sulfate e/	47	42	41	40	40
Ammonia liquor e/	5	4	4	4	4
Total e/	52	45	44	44	44
Grand total	12,700	12,800	13,400 r/	12,600 r/	13,400

e/ Estimated. p/ Preliminary. r/ Revised.
1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.
2/ Current Industrial Reports, MA28B, M28B, and MQ28B Bureau of the Census.
3/ Quarterly Coal Report, U.S. Department of Energy. Production estimates based on reported coke production trend.

TABLE 3
MAJOR DOWNSTREAM NITROGEN COMPOUNDS PRODUCED IN THE UNITED STATES 1/ 2/

(Thousand metric tons)

Compound	1990	1991	1992	1993 r/	1994 p/
Urea:					
Gross weight	7,450	7,380	7,950 r/	7,520	7,320
Nitrogen content	3,430	3,390	3,660 r/	3,460	3,370
Ammonium nitrate:					
Gross weight	7,000	7,090	7,240 r/	7,490	7,990
Nitrogen content	2,450	2,480	2,530 r/	2,620	2,800
Ammonium phosphates: 3/					
Gross weight	15,900	16,400	17,200 r/	15,900	15,800
Nitrogen content	2,670	2,710	2,920	2,680	2,660
Ammonium sulfate: 4/					
Gross weight	2,290	2,040	2,170	2,200	2,310
Nitrogen content	485	432	460	466	489
Nitric acid, direct use: 5/					
Gross weight	1,680	1,610	1,680 r/	1,840	1,710
Nitrogen content	374	357	373 r/	408	381
Acrylonitrile:					
Gross weight	1,370	1,200	1,280	1,130	1,400
Nitrogen content	363	318	338	298	369
Caprolactam:					
Gross weight	626	582	625	650	763
Nitrogen content	78	73	78	81	95
Total:					
Gross weight	36,300	36,300	38,200 r/	36,700	37,300
Nitrogen content	9,850	9,770	10,400	10,000	10,200

p/ Preliminary. r/ Revised.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ Ranked in relative order of importance.

3/ Diammonium phosphate (DAP), monoammonium phosphate (MAP), and other ammonium phosphates.

4/ Excludes coke plant ammonium sulfate.

5/ Gross nitric acid production netted for use in production of ammonium nitrate.

Sources: Bureau of the Census and International Trade Commission.

TABLE 4
DOMESTIC PRODUCERS OF ANHYDROUS AMMONIA IN 1994 1/

(Thousand metric tons per year of ammonia)

Company	Location	Capacity 2/
Air Products and Chemicals Inc. 3/	New Orleans, LA 4/	263
Do.	Pace Junction, FL 5/	45
Allied Chemical Corp.	Hopewell, VA 4/	392
Avondale Ammonia 6/	Fortier, LA	404
Dakota Gasification Co.	Beulah, ND	22
Arcadian Corp.	Augusta, GA	522
Do.	Clinton, IA	236
Do.	Geismar, LA 4/	500
Do.	LaPlatte, NE	177
Do.	Lima, OH 7/	494
Do.	Woodstock, TN	308
Borden Chemical Co.	Geismar, LA	386
Carbonaire Co. Inc. 8/	Palmerton, PA	--
CF Industries Inc.	Donaldsonville, LA	1,630
Chevron Chemical Co.	El Segundo, CA	18
Do.	St. Helens, OR	77
Coastal Chem, Inc.	Cheyenne, WY	167
Cominco American Inc.	Borger, TX 4/	386
Diamond Shamrock	Dumas, TX	127
E.I. du Pont de Nemours & Co. Inc.	Beaumont, TX	445
Farmland Industries Inc.	Beatrice, NE	236
Do.	Dodge City, KS	235
Do.	Enid, OK	923
Do.	Fort Dodge, IA	220
Do.	Hastings, NE	(9/)
Do.	Lawrence, KS	408
Do.	Pollock, LA 4/	454
First Mississippi Corp. (Ampro)	Donaldsonville, LA	440
Green Valley Chemical Corp.	Creston, IA	32
IMC-Agrico 10/	Donaldsonville, LA	480
Koch Industries	Sterlington, LA	998
Jupiter Chemicals	West Lake, LA	27
LaRoche Industries Inc.	Cherokee, AL	159
Mississippi Chemical Corp.	Yazoo City, MS	454
Monsanto Co.	Luling, LA	445
Phoenix Chemical Co.(Vigoro)	East Dubuque, IL	260
PPG Industries Inc. 11/	Natrium, WV	--
J.R. Simplot Co.	Pocatello, ID	93
Terra International, Inc.	Port Neal, IA 12/	308
Do.	Blytheville, AR 13/	363
Do.	Verdigris, OK 13/	907
Do. (Oklahoma Nitrogen)	Woodward, OK	408
Trial Chemical Co. 14/	Donaldsonville, LA	408
Union Chemical Co. (Unocal)	Kenai, AK	1,130
Wil-Grow Fertilizer Co.	Pryor, OK	85
Total		16,100

1/ Data rounded by the U.S. Bureau of Mines to three significant digits; may not add to total shown.
2/ Engineering design capacity adjusted for 340 days per year of effective production capability.
3/ Closed late-1994 to early-1995.
4/ Revamp and/or retrofit.
5/ Capacity cut 50% at yearend 1993.
6/ Joint venture between American Cyanamid and LaRoche Industries formed in 1994.
7/ Purchased from B.P. Intl. Ltd. in 1993.
8/ Closed in 1993.
9/ Plant (140,000 tons per year) mothballed.
10/ Joint venture formed mid-year 1993; Freeport-McMoRan owns Agrico.
11/ Closed in 1994.
12/ Plant damaged Dec. 1994 as a result of explosion in Ammonium Nitrate section.
13/ Former Agricutural Minerals (AMC) plants sold to Terra International in 1994.
14/ Joint venture between First Mississippi Corp. and Mississippi Chemical Corp.

Sources: International Fertilizer Development Center (IFDC); North American Fertilizer Capacity, Ammonia, Apr. 1995. Blue, Johnson and 'Associates, North American NPK Plants and Capacities, Foster City, CA.

TABLE 5
CONSUMPTION TRENDS FOR MAJOR NITROGEN COMPOUNDS
PRODUCED IN THE UNITED STATES 1/ 2/

(Thousand metric tons of contained nitrogen)

	1990	1991	1992	1993	1994 p/
Fertilizer materials:					
Urea:					
Solid	1,920	1,870	1,900 r/	1,770	1,860
Solution	1,160	1,140	1,320	1,300 r/	1,150
Total	3,080	3,010	3,230 r/	3,070 r/	3,000
Ammonium phosphates 3/	2,670	2,710	2,920	2,680 r/	2,660
Ammonium nitrate:					
Solid	697	696	702 r/	707 r/	707
Solution	1,020	1,170	1,190 r/	1,240 r/	1,320
Other 4/	68	15	2	-1 r/	-- e/
Total	1,780	1,880	1,900 r/	1,950	2,030
Ammonium sulfate:					
Synthetic and byproduct	485	432	460	466 r/	489
Coke oven byproduct e/	52	45	44	44	44
Total	537	477	504	510 r/	533
Total fertilizer	8,070	8,080	8,590	8,210 r/	8,220
Nonfertilizer materials:					
Urea: 3/					
Feed	82	95	104	110 r/	104
Industrial	270	289	329	279 r/	259
Total	352	384	433	389 r/	363
Ammonium nitrate 3/	667	605	636	673 r/ e/	771 e/
Nitric acid	374	357	373 r/	408 r/	381
Acrylonitrile	363	318	338	298 r/	369
Caprolactam	78	73	78	81 r/	95
Total nonfertilizer	1,830	1,740	1,860	1,850 r/	1,980
Grand total	9,900	9,820	10,400	10,100 r/	10,200

e/ Estimated. p/ Preliminary. r/ Revised.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ Ranked in relative order of importance.

3/ Solid and solution.

4/ Unaccounted distribution.

Sources: Current Industrial Reports, MA28B and MQ28B, Bureau of the Census; and, International Trade Commission.

TABLE 6
U.S. NITROGEN FERTILIZER CONSUMPTION,
BY PRODUCT TYPE 1/ 2/

(Thousand metric tons nitrogen)

Fertilizer material 3/	1993	1994 p/
Single-nutrient:		
Anhydrous ammonia	3,260 r/	4,120
Nitrogen solutions 4/	2,370 r/	2,420
Urea	1,640	1,680
Ammonium nitrate	592	609
Ammonium sulfate	166	180
Aqua ammonia	61	78
Other 5/	134 r/	221
Total	8,220 r/	9,310
Multiple-nutrient 6/	2,120 r/	2,160
Grand total	10,300	11,500

p/ Preliminary. r/ Revised.
1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.
2/ Fertilizer years ending June 30.
3/ Ranked in relative order of importance by product type.
4/ Principally urea-ammonium nitrate (UAN) solutions.
5/ Includes other single-nutrient nitrogen materials, all natural organics, and statistical discrepencies.
6/ Various combinations of nitrogen (N), phosphate (P), and potassium (K): N-P-K, N-P, and N-K.

Source: Commercial Fertilizers. Prepared as a cooperative effort by the Tennessee Valley Authority, The Fertilizer Institute, and the Association of American Plant Food Control Officials, Dec. 1994.

TABLE 7
U. S. PRODUCER STOCKS OF
FIXED NITROGEN COMPOUNDS
AT YEAREND 1/ 2/

(Thousand metric tons nitrogen)

Material 3/	1993	1994 p/
Ammonia	852 r/	956
Nitrogen solutions 4/	305	295
Urea	226 r/	175
Ammonium nitrate	96 r/	90
Ammonium phosphates 5/	88 r/	87
Ammonium sulfate	34	48
Total	1,600 r/	1,650

p/ Preliminary. r/ Revised.
1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.
2/ Calendar year ending Dec. 31.
3/ Ranked in relative order of importance.
4/ Urea-ammonium nitrate and ammoniacal solutions.
5/ Diammonium, monoammonium, and other ammonium phosphates.

Source: Current Industrial Reports, MA28B and MQ28B, Bureau of the Census.

TABLE 8
PRICE QUOTATIONS FOR MAJOR NITROGEN COMPOUNDS
AT YEAREND

(Per metric ton product)

Compound	1993	1994
Ammonium nitrate: f.o.b. Corn Belt 1/	$138-$149	$165-$176
Ammonium sulfate do.	133-147	125-149
Anhydrous ammonia:		
F.o.b Corn Belt	157-171	254-265
F.o.b. gulf coast 2/	143-146	240-254
Diammonium phosphate: F.o.b. central Florida	152-154	184-190
Nitrogen solutions (28% to 32%):		
F.o.b. South Central 3/	99-112	117-124
Urea:		
F.o.b. Corn Belt, prilled	141-165	204-215
F.o.b. gulf coast, granular 2/	139-141	219-226
F.o.b. gulf coast, prilled 2/	128-130	204-213

1/ Illinois, Indiana, Iowa, Missouri, Nebraska, and Ohio.
2/ Barge, New Orleans.
3/ Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Tennessee, and Texas.

Source: Green Markets, Fertilizer Market Intelligence Weekly, Dec. 20, 1993, and Jan. 2, 1995.

TABLE 9
U.S. EXPORTS OF ANHYDROUS AMMONIA, BY COUNTRY 1/

(Thousand metric tons ammonia)

Country	1993	1994 p/
Korea, Republic of	284	201
Mexico	6	27
Australia	--	25
Canada	21	2
China	(2/)	1
Taiwan	13	1
Costa Rica	36	(2/)
Jamaica	2	1
Suriname	2	1
Morocco	50	--
South Africa, Republic of	23	--
Norway	21	--
Other 3/	2	2
Total	460	261

p/ Preliminary.
1/ Value data suppressed by Bureau of the Census. Ranked in relative order of importance by country and geographics.
2/ Less than 1/2 unit.
3/ Fifteen countries, principally in Latin America.

Source: Bureau of the Census.

TABLE 10
U. S. IMPORTS OF ANHYDROUS AMMONIA, BY COUNTRY AND REGION 1/

(Thousand metric tons ammonia)

Country/Region 2/	1993		1994 p/	
	Gross weight	Value 3/ (thousands)	Gross weight	Value 3/ (thousands)
Trinidad and Tobago	986	$127,000	1,380	$252,000
Canada	979	129,000	1,130	161,000
Russia and Ukraine 4/	631 5/	81,900	783	145,000
Latvia	25 5/	NA	70	15,200
Mexico	285	38,300	526	93,200
Venezuela	82	10,500	78	14,000
Brazil	--	--	33	6,180
Middle East 6/	141	14,600	138	27,800
West Europe 7/	53	7,330	38	8,040
Algeria	50	6,010	12	2,760
Japan	(8/)	21	(8/)	27
India	--	--	3	385
Total	3,230	415,000	4,200	725,000

p/ Preliminary. NA Not available.
1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.
2/ Ranked in relative order of importance by country and region.
3/ C.i.f. value.
4/ Independent republics of the former U.S.S.R., effective Jan. 1992.
5/ Tonnage data based on the U.S. Bureau of Mines industry intelligence. Data suppressed by Bureau of the Census since Jan. 1, 1989.
6/ Saudi Arabia, Bahrain, Kuwait, and Qatar, in order of importance.
7/ The Netherlands, Germany, Norway, France, the United Kingdom, and Portugal, in order of importance.
8/ Less than 1/2 unit.

Sources: Bureau of the Census and U.S. Bureau of Mines.

TABLE 11
U.S. EXPORTS OF MAJOR NITROGEN COMPOUNDS IN 1994 1/

(Thousand metric tons)

Compound	1993			1994		
	Gross weight	Nitrogen content	Value 2/ (thousands)	Gross weight	Nitrogen content	Value 2/ (thousands)
Fertilizer materials:						
Ammonium nitrate 3/	66	22	NA	55	18	NA
Ammonium sulfate 3/	757	159	NA	762	160	NA
Anhydrous ammonia	460	378	NA	261	215	NA
Diammonium phosphate	7,240	1,300	NA	9,190	1,660	NA
Monoammonium phosphate	1,100	121	NA	1,480	162	NA
Nitrogen solutions	28	8	NA	119	35	NA
Sodium nitrate	2	(4/)	NA	2	(4/)	NA
Urea	659	303	NA	912	419	NA
Mixed chemical fertilizers 5/	329	52	NA	387	61	NA
Other ammonium phosphates 6/	69	11	NA	54	8	NA
Other nitrogenous fertilizers 7/	171	7	NA	189	9	NA
Total	10,900	2,370	NA	13,400	2,740	NA
Industrial chemicals:						
Ammonia, aqua (ammonia content)	20	16	$1,620	25	20	$1,860
Ammonium compounds 8/	9	3	8,840	14	4	10,900
Ammonium phosphate (ortho)	(4/)	(4/)	152	(4/)	(4/)	27
Potassium cyanide	(4/)	(4/)	1,130	(4/)	(4/)	765
Sodium cyanide	62	17	50,900	69	20	63,600
Other cyanides and cyanates	1	(4/)	6,260	3	1	8,710
Hydrazine, hydroxylamine and related inorganic salts	13	6	21,300	16	8	33,700
Bismuth/silver nitrates	(4/)	(4/)	7,230	(4/)	(4/)	13,900
Potassium nitrate	18	3	4,440	6	1	3,520
Other nitrates	4	1	7,850	9	2	6,480
Nitric/sulfonitric acids	15	3	5,280	17	3	6,190
Nitrates	7	1	4,120	9	2	6,330
Total	149	50	119,000	169	59	156,000
Grand total	11,000	2,410	NA	13,600	2,800	NA

NA Not available.
1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.
2/ Export values f.a.s.
3/ Includes industrial chemical products.
4/ Less than 1/2 unit.
5/ Harmonized codes 3105.10.0000 and 3105.20.0000.
6/ Codes 3105.51.0000, 3105.59.0000, and 3102.70.0000.
7/ Codes 3101.00.0000, 3102.29.0000, 3102.60.0000, and 3102.90.0000.
8/ Carbonates, chloride, fluorides, and tungstate.

Source: Bureau of the Census. Effective Jan. 1, 1989, U.S. exports and imports were reported under the new international Harmonized Co and Coding System (Harmonized System).