NITROGEN

By George A. Rabchevsky

Nitrogen gas comprises almost 80% of the air and occurs in the protein matter of all living things, in many organic compounds, in ammonia and ammonia salts, and in nitrate mineral deposits primarily in Bolivia and Chile. Liquid and gaseous nitrogen is produced entirely from the air. The resources of nitrogen in the atmosphere are unlimited. The air is constantly replenished with nitrogen primarily from the decomposition of organic materials.

Nitrogen gas must be converted to a different form before plants can use it. Nitrogen is rarely found in minerals because of the solubility of nitrates. The only part of soil that supplies nitrogen to a plant is organic matter, such as rotting plant debris and animal manure. As organic matter is broken down (mineralized) by soil microbes, nitrogen contained in its complex molecules is converted to simpler inorganic forms, ammonium and nitrate, the only forms that can be used by plants. The process is called nitrogen fixation. In addition, some nitrogen is fixed each time there are thunderstorms. Electrical discharge (lightning) forms mineral nitrogen that enters the soil with precipitation (rain) and other atmospheric reactions. Nitrogen contained in anhydrous ammonia and its downstream fertilizer derivatives is produced in about 75 countries around the globe and provides more than 50% of the world's essential plant nutrient demand for food and fiber.

Until the early 1900's, the nitrogen source in farm soils was entirely derived from natural sources: from mineral resources such as Chilean nitrates, from manure and the putrefaction of vegetable wastes; and from ammonium sulfate from coal coking, seed meals, sewage sludges, and food processing byproducts.[1] As population rises, food demand and food production also increase. To increase food production, new farming techniques began to evolve. Crop rotation, the availability and transportation of manure were inefficient and too expensive in 1930's. Thus, following World War II, commercial production of nitrogen as a plant food (fertilizer) began. Its base is the production of anhydrous ammonia (NH_3), made by combining nitrogen (from the atmosphere) with hydrogen (from natural gas and other sources). The source of nitrogen is always air; hydrogen can be derived from a variety of raw materials including water, light and heavy hydrocarbons resulting from crude oil refining, coal, natural gas, and sometimes a combination of these raw materials. In all cases, part of the hydrogen produced is derived from water. The Haber-Bosch process has changed little since its commercialization in 1913. Extensive coal deposits in Europe provided the feedstock for its ammonia industry. The North American ammonia industry was based primarily on abundant supplies of low-cost natural gas. Using ammonia, other nitrogen fertilizers are produced through a variety of processes. Almost all commercial nitrogen fertilizer is derived from synthetic ammonia.

In the United States, there were 27 ammonia producers with 43 locations in 1995, compared with 52 producers and 80 locations in 1980. Production of anhydrous ammonia (82.2% nitrogen) decreased slightly in 1995 from output in 1994. Production and apparent consumption values were based on average annual f.o.b. gulf coast spot prices, which decreased 23% during the year. Most nitrogen fertilizer is water soluble and much of it can be leached from most soils. In 1995, 80% to 90% of ammonia consumption was by the fertilizer industry, the rest by the industrial sector. Consumption of nitrogen is more than double that of either phosphate as P_2O_5 or potash as K_2O, the other two major fertilizer products.[2]

An increase in ammonia exports was attributed to marketing practices by U.S. ammonia exporters and the appearance of a temporary European market. Imports of ammonia decreased by about 25% in 1995.

Industry statistics for anhydrous ammonia and derivative products were developed by the Bureau of the Census, U.S. Department of Commerce. In 1991, Bureau of Census started publishing the quarterly series MQ28B, under product codes 28731, 28732, and 28742 in Current Industrial Reports (CIR), Fertilizer Materials. Final data are subsequently published in a companion annual report MA28B. The Bureau of Census surveys approximately 250 producers of inorganic fertilizer materials. Statistics covering industrial gases were reported in the Bureau of the Census CIR publications M28C, M28QC, and MA28C, Industrial Gases.

Production

The United States remained the world's second largest producer and consumer of elemental and fixed types of nitrogen, following China. In 1995, the United States produced 13.3 million metric tons of ammonia; ammonia producers operated at 100% of design capacity. (*See table 1.*) Ammonia ranked as the sixth largest volume chemical produced in the United States. 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. (*See tables 2 and 3.*)

Nearly 60% of total U.S. ammonia production capacity was concentrated in the States of Louisiana (39%), 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 56% of total U.S. ammonia capacity, in order of importance. (*See table 4.*)

Arcadian was expanding its ammonia and nitrogen solutions capacities at its Augusta, GA, and Geismar, LA, facilities.[3] At Augusta, annual ammonia capacity is to grow to 575,000 tons and solutions capacity to 660,000 tons. At Geismar, Arcadian is to add a nitric acid plant moved from Gibbstown, NJ. Annual nitric acid capacity is expected to grow to 500,000 tons. Nitrogen solutions capacity is to increase from 1.02 million to 1.14 million tons.[4] Arcadian acquired a 50% interest in a partnership that owned a 30,000-ton ammonia terminal on the Houston ship channel. The other 50% was owned by subsidiaries of First Mississippi Corp. This interest will increase Arcadian ammonia distribution capability.[5]

CF Industries Inc. (CF) started its business in 1946, becoming one of the leaders in the fertilizer industry. In the 1940's, the company manufactured nitrogen and phosphate fertilizer products. In September 1995, CF approved funds for the reconfiguration of its Donaldsonville nitrogen complex. Once remodeled, three new units will produce urea, nitric acid, and urea-ammonia-nitric (UAN) liquid solutions as fertilizers. Total planned nitrogen fertilizer production capacity should remain unchanged; at about 1 million tons per year of granular urea, 1.2 million tons per year of UAN solutions, and almost 2 million tons per year of ammonia. Uhde GmbH, Dortmund, Germany, was awarded the contract for the project.[6]

LaRoche Industries, Inc., Atlanta, GA, reorganized its Nitrogen Products Group into two marketing groups, Industrial Nitrogen and Agricultural Nitrogen.[7] The Industrial Nitrogen Group handled sales of industrial ammonia, explosives-grade ammonium nitrate, and nitric acid. Agricultural nitrogen was supplied from LaRoche production facilities in Cherokee, AL; Morris, IL; Baton Rouge and Gramercy, LA; Crystal City, MO; and Orem, UT. The company also manufactured ammonia at Fortier, LA, through a joint venture managed by Cytec Industries Inc.[8]

LaRoche continued to expand ammonia production facilities at Cherokee, AL, from 159,000 tons to 222,000 tons per year, completing phase III of the expansion, which began in September 1994, and was expected to be completed by mid-1997. Phase II development, expected to be completed at the end of 1996, would add 50,000 tons per year to ammonia nitrate capacity and update one of the two nitric acid plants at the complex. The phase III expansion is to provide feedstock for the phase II development. Other products manufactured at the site included UAN liquid solutions.[9]

Mississippi Chemical Corp. (MCC) reported record income for the year ended June 30. Nitrogen net sales for the year were $255.2 million, up from the prior year's $240.7 million. About 2 million tons were sold, slightly up from 1994. MCC manufactures fertilizers, produces and markets phosphate, potash, and nitrogen, the three primary crop nutrients. Nitrogen fertilizer is manufactured at the company's facilities in Yazoo City, MS, and at Triad Chemical, a 50% joint venture at Donaldsonville, LA. The company produces potash at Carlsbad, NM, and diammonium phosphate at Pascagoula, MS.

Consumption

In the United States, over 80% of fixed nitrogen was for fertilizer use and the rest for the industrial sector. Even though other chemical uses are increasing and new uses can be expected, nitrogen consumption in fertilizers was the major factor influencing the growth in demand. Urea and UAN were used in the fertilizer and industrial sectors in both solid and liquid form. UAN solution fertilizers containing 28% to 32% nitrogen (N) gained favor with users because of their safe handling and storage characteristics and ease of application.

Elemental nitrogen is used extensively by the electronics, metals, food, and aerospace industries because of its unique inert and cryogenic properties. In the industrial sector, anhydrous ammonia derivatives, such as urea, are important for the production of synthetic fibers, resins and polymers, explosives, animal feed, and a wide variety of inorganic and organic compounds. Field application of anhydrous ammonia requires knifing of the gas into the soil considerably below the surface to prevent escape to the atmosphere. Aqua ammonia, a simple solution of ammonia in water, is used to a limited extent as a nitrogen fertilizer (20% N).

Ammonium phosphate compounds were consumed primarily as domestic fertilizer and for export. High-purity materials were used as the active ingredient in fire extinguishers, and the lower agricultural-grade materials were utilized as fire retardants for forest fires and other purposes. Monoammonium phosphate (MAP) and diammonium phosphate (DAP) are commonly applied to the two general classes of ammonium phosphates. In general, phosphoric acid and anhydrous ammonia are reacted to produce the desired grade of ammonium phosphate.[10]

Ammonium nitrate was used primarily in solid and liquid fertilizers, in industrial explosives, and as blasting agents. After World War II, ammonium nitrate became the leading solid nitrogen fertilizer in the United States and worldwide, and remained such until about 1975, when its use was surpassed by synthetic urea. In the United States, only high grade (33% to 34% N) ammonium nitrate is produced, and because of the oxidizing nature and explosive potential of this material, strict handling precautions are required.

Ammonium sulfate was used mostly as a fertilizer material, valued for its nitrogen content (21.2% N) and for its readily available sulfur content (24.3% S). It is most commonly produced as a byproduct of caprolactam production, an intermediate in nylon manufacture. Byproduct from acid scrubbing of coke oven gas is another source, but now almost none is being produced. Since the introduction of ammonium nitrate and urea, the relative importance of ammonium sulfate worldwide has steadily decreased. Nonfertilizer uses include food processing, fire control, tanning, and cattle feed.[11]

Nitric acid was used in chemical synthesis and in metal treatment. Nitration reactions with benzene, phenol, and toluene produce dyestuffs, pharmaceutical products, trinitrotoluene explosives, and disinfectants. 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 and polyester fibers (nylon), respectively.

Acrylonitrile and caprolactam were used in the production of acrylic and nylon fibers, resins, and plastics. (*See table 3.*)

Other uses of ammonia are for the production of amines, cyanides, and methyl methacrylate polymers (plexiglass); liquid home and industrial cleaners; pulp and paper products; industrial refrigeration; metallurgy; and as a propellant in vehicular air bags.

Stocks

At yearend 1995, stocks of fixed nitrogen compounds totaled 2.2 million tons of contained nitrogen, an increase of 36% from 1994. (*See table 6.*)

Transportation

Ammonia was transported by refrigerated barge, rail, pipeline, and truck. Three companies serve 11 States with pipelines 4,900 kilometers in length, with 4,800 kilometers of river barge transport, and by rail and truck used primarily for interstate or local delivery.

Koch Industries operated the Gulf Central ammonia pipeline from the Gulf of Mexico (Louisiana) to the Midwest as far north as Iowa, covering 3,065 kilometers, and to the east to Huntington, OH. 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 a pipeline that extended from Borger in northern Texas to Mankato in southern Minnesota, covering 1,700 kilometers. The Mapco pipeline had an annual capacity of over 1 million tons and about 500,000 tons of ammonia storage capacity.

CF Industries, Inc. and Cargill Fertilizer, Inc. jointly operated the Tampa Bay Pipeline (TBP) with a 135-kilometer route. TBP moved nitrogen compound and ammonium phosphate for fertilizer producers in Hillsborough and Polk Counties, FL.

Capacities for trucks and railcars are usually 20 to 100 tons respectively, depending on the product loaded and the volume of the container. Barges can accomodate from 400 to 2,000 tons.

Ammonium nitrate is transported by rail, road, and water; but its transportation on U.S. navigable waterways is restricted. Urea is shipped either in bulk or as bagged material.

Prices

Ammonia prices decreased slightly in 1995 as quoted f.o.b. barge Gulf Coast and Corn Belt. Urea prices varied, rising f.o.b. Corn Belt and prilled f.o.b. gulf coast, while decreasing slightly for granular material. Ammonium nitrate prices also fell slightly at the close of the year. Diammonium phosphate prices were quoted at $215 per ton f.o.b. central Florida at yearend 1995, an increase of 14% compared with the same period in 1994. (*See table 7.*)

Foreign Trade

Ammonia exports were up by 48% compared with that of 1994. Ammonia phosphate exports increased by about 6% in 1995. U.S. nitrogen compounds (N content) exports, in total, increased by 250,000 tons, or 10% above 1994 levels. (*See tables 8 and 10.*)

U.S. ammonia imports dropped 24% in 1995, compared with a record high of 4.2 million tons reached in 1994. Trinidad and Tobago and Canada supplied 83% of total U.S. ammonia import tonnage. U.S. nitrogen compounds imports in 1995 decrease slightly; however, several products increased over that of 1994, such as ammonium nitrate and diammonium phosphate. (*See tables 9 and 11.*)

World Review

Anhydrous ammonia and other nitrogen materials were produced in more than 80 countries. U.S. private investment was well-represented in many of the foreign plants, notably in Canada, Latin America, and Europe.

Geographically, about 22% of global ammonia production originated in China; Asia contributed 40% of world total ammonia production. The United States and Canada represented 18% of the global total, with the United States accounting for 79% of the region. Countries in the former Soviet Union were 14% of the total; Western Europe, 11%; Middle East, 7%; Latin America, 7%; Eastern Europe, Africa, and Oceania contributed the rest. (*See table 12.*)

Global ammonia production in 1995 increased slighlty relative to 1994 levels. Total ammonia production was 91.6 million tons N in 1995, based on data reported by the U.S. Geological Survey. Production increased slightly or remained flat in most regions except for the former Soviet Union and Romania, where a downward slide continued since the dissolution of the Soviet Union in 1991.

World ammonia exports increased 8% to 10.8 million tons in 1995. Russia, Trinidad and Tobago, Ukraine, and Canada accounted for 57% of the world total, in order of importance. Western Europe imported 33% of global ammonia trade, followed by the United States (32%) and Asia (8%).[12]

World urea production increased 8.5% to 41.5 million tons N in 1995, representing 42% of world ammonia N production. China and India dominated the world urea market with 37%. The United States and Canada produced about 12% of the total.

World urea trade rose 8% to 11.2 million tons N in 1995. Russia and Ukraine accounted for 27% of total exports; Middle East, 21%; Eastern Europe, 12%; Far East, 12%; Canada and the United States, 11%; Western Europe, 9%; Latin America, 7%; and Africa and Oceania shipped minor tonnages.[13]

China, the United States, India, and Vietnam accounted for 59% of global urea imports, in order of importance. Urea imports in Western Europe, after a large increase of 42% in 1994, declined slightly in 1995 to 1.4 million tons. Urea imports in the Middle East, after falling 37% in 1994, rose 24% in 1995. Regionally, countries in the Far East accounted for

55% of global urea imports; North America and Western Europe, 13% each; Latin America, 11%; Oceania, Africa, and the Middle East, 3%, 3%, and 2% respectively; with Eastern Europe and other locations accounting for the remainder.

Canada.—In 1995, Canada produced 3.5 million tons of ammonia, rising 8% from 1994; exports declined 11% to 842,000 tons and imports rose 78% to 700,000 tons. Urea production rose 4% to 1.4 million tons, and exports declined 9% to 769,000 tons. There were seven ammonia plants in Canada, with a total capacity of 3.8 million tons in 1995. Sherritt Inc. was the largest, with 31% of total production capacity.

Far East.—**China**.—China was the largest producer of ammonia in the world, additionally importing 840,000 tons in 1995, and with no exports. China's efforts to increase fertilizer self-sufficiency lag behind goals because of increased demand by the farmers. A small proportion of nitrogen comes from urea and DAP, and China lacks such production facilities. Most Chinese nitrogen plants are small, with only about 6% of the fertilizer production facilities being large or medium-sized. China's ninth 5-year plan, which runs from 1996 to 2000, proposed to raise urea production to 8 million tons; in 1995, China already produced 8.1 million tons. The Chinese Government has also established a new energy agency to work with overseas companies in the development of China's deposits of coal- bed methane, which can be used as a feedstock for nitrogen production.[14]

India.—In India, 26 plants produced ammonia with a total capacity of 9.2 million tons in 1995. National Fertilizers Ltd. was the largest, with a capacity of 1.2 million tons, followed by Rashtriya Chemical & Fertilizers Ltd. with 1.1 million tons. Urea imports in 1995 set another record of 1.5 million tons N. The future policy in India remains uncertain, as the present urea subsidy program could change.

Russia.—Russia was the fourth largest producer of ammonia after China, the United States, and India, with an output of 7.5 million tons in 1995, and the largest exporter at 2.6 million tons. Most exports were to Western Europe, Africa, and Middle East.

After adopting an intergovernmental agreement on a customs union between Russia and Belarus, Gazprom has begun to supply gas to fertilizer producers in Belarus at the same price as to Russian producers (about $58 per thousand cubic meters). Gazprom threatened to cut gas supplies to Ukraine because of unpaid 1995 debts, totaling about $900 million. Gazprom continued supplying gas to Lithuania, because the country started to pay for its gas deliveries.[15]

Latin America.—Latin America is considered one of the fastest growing agricultural markets in the world. The available large gas reserves in the Caribbean area, Trinidad and Tobago, Mexico, and Venezuela will eventually make those countries world-ranking in nitrogen supplies. An estimated capacity for ammonia (N) in 1995 was 5.5 million tons per year and for urea, 2 million tons per year.

Argentina.—For many years, Petroquimica Argentina SA was Argentina's only fertilizer producer. Its plant at Campana operated at full capacity in 1995, with 73,000 tons per year N ammonia and 118,000 tons per year urea. Demand for fertilizers rose, so the company increased its capacity at Campana by 50% to 177,000 tons per year urea.[16]

Brazil.—Brazil accounts for 50% of the fertilizer consumed in Latin America. In 1992-93, Brazil privatized many fertilizer producers. Ultrafertil, part of the Fertiphos Group, is modernizing its ammonia plant at Piacaguera to reduce energy consumption and increase capacity from 190,000 tons per year to 220,000 tons per year ammonia. Ultrafertil supplies 45% of the ammonia and all of Brazil's production of ammonium nitrate.

Chile.—The only commercially exploited mineral to be used as a fertilizer in Chile was nitrate. It occurs as an impure sodium nitrate, known as caliche. Sociedad Quimica y Minera de Chile SA (SQMC), the only producer of natural nitrates, exports to Latin America, China, North America, and Western Europe. The principal product is sodium nitrate with 16% nitrogen content, known as Chilean nitrate or Chilean saltpeter. Farmers often refer to it simply as soda. SQMC produces about 840,000 tons per year of nitrate, 400,000 tons of sodium sulfate, and 5,000 tons of iodine.

Cia Minera Yolanda SA expected to bring into production a new 300,000-ton-per-year nitrate mine in the Atacama Desert in northern Chile by 1997. Minera Yolanda was 95%-owned by Vancouver-based Kap Resources Inc. and 5% by Interamerican Investment Corp., a division of Interamerican Development Bank. One of Kap's major shareholders, the Potash Corp. of Saskatchewan Inc. planned to distribute the production from the new mine. The Yolanda property is 400 kilometers south of the operations of SQMC.

Enaex SA planned to construct a 400-ton-per-day ammonia plant, the nation's first, in Cabo Negro in southern Chile. Enaex also began to increase its ammonium nitrate capacity with a new plant at an existing site at the northern Chilean port of Mejillones.[17] The ammonia facility's natural gas feedstock will be supplied by Empresa Naciónal de Petróleo, the state oil and gas company, which will be a minority partner (30%) in the new venture. The existing ammonia reception and storage facilities at Mejillones are to be upgraded to accommodate the expansion; a second ammonia storage tank (capacity 20,000 tons) was finished in mid-1996.[18]

Mexico.—The Mexican fertilizer industry was transformed in 1992, when State-owned Fertimex was broken up into 10 production units and sold to the private sector. However, the newly independent companies still have to procure their ammonia feedstock from the nationalized Pemex organization. Ammonia production facilities did not form an integrated part of urea complexes in Mexico, and they also belonged to a different proprietor, which was in charge of exploiting the country's oil resources. Pemex's seven ammonia plants at Camargo, Cosoleacaque, and Salamanca are slated for sale, and their transfer to private ownership was expected to be completed by the yearend 1996.[19]

Trinidad and Tobago.—On January 30, 1996, MCC and Farmland Industries, Inc. (FI) announced the construction of its ammonia facility in the La Brea Industrial Estate in Trinidad, to be completed in early 1998. Farmland MissChem Limited

(FMC) is a joint venture between MCC and Farmland Industries. M. W. Kellogg Co. (Kellogg) of Houston, TX, was contracted to construct a 600,000-ton-per-year ammonia plant. FMC reached an agreement with the Government of Trinidad and Tobago and the National Gas Co. of Trinidad and Tobago Ltd. related to its planned ammonia facility. FI is the largest farmer-owned regional cooperative in the United States.[20]

Arcadian planned to initiate production of ammonia at its third Trinidad ammonia plant in April 1996. The plant, with a capacity of 680,000 tons per year, was relocated from Brea, CA, to the Point Lisas complex in Trinidad. Kellogg was selected as the main contractor for the development using its own process technology. All three of Arcadian's plants are located in Point Lisas, with total capacity of over 1.2 million tons per year.

Venezuela.—The Venezuelan production of ammonia and urea continued to grow in 1995 and reached 600,000 tons and 396,000 tons, respectively. Venezuela was a leading exporter of ammonia to the U.S. market, with 66% of its total exports of 93,200 tons to that destination in 1995. State-owned Pequiven SA considered building three new ammonia plants and two additional urea units, which would have a total capacity of 1.8 million tons per year ammonia and 1.6 million tons per year urea.[21]

Current Research and Technology

General Electric Environmental Services, Inc. (GEES) has developed, patented (1987) and commercialized (1994) an innovative process for the production of ammonium sulfate. The process produces high-quality ammonium sulfate through the removal of unwanted sulfur dioxide from utility or industrial boiler flue gas by reacting it with ammonia and air to form ammonium sulfate. The production of ammonium sulfate is a byproduct of cleaner air and energy. This process uses the waste energy from the boiler flue gas to crystallize the product by evaporation of excess water. The GEES system uses a solid waste removal system to remove captured particulate from the ammonium sulfate slurry prior to dewatering, thus maintaining the product purity. In the process, no additives or other compounds are added in the production of ammonium sulfate. The first commercial Ammonium Sulfate Forced Oxidation system was being installed at the Dakota Gasification Co.'s Great Plains Synfuels Plant near Beulah, ND. The plant was designed to produce more than 500 tons per day of granular and standard ammonium sulfate.[22]

Outlook

Production of nitrogen in the United States is expected to increase in 1996. The consumption of nitrogen is projected to grow at least 3% per year in the late 1990's. The Fertilizer Institute in Washington, DC, predicted that total nitrogen demand is to increase at an annual rate of 2.4% in Canada and 1.7% in the United States by the year 2000. Production of ammonia, and UAN are foreseen to increase, with ammonia leading with about a 5% growth rate; production of ammonium nitrate and ammonium sulfate are expected to decrease slightly. UAN plants are being expanded by several companies in Iowa, Kansas, Nebraska, and other States.

Analysts believe that farm exports could jump as much as 60% over the next 10 years. That growth will be stimulated by the anticipated global economic expansion, rising incomes in developing countries, population growth, declining trade barriers, and the trend toward consumer confidence.

The final rule for industry Risk Management Plans is expected to be signed in 1996 by the U.S. Environment Protection Agency (EPA). The rule covers plants, terminals, and dealerships that handle more than 10,000 pounds of anhydrous ammonia, 20,000 pounds of aqua ammonia in 20% solution, or 15,000 pounds of nitric acid in concentrations of over 80%. The rule, prompted by 1990 amendments to the Clean Air Act (CAA), requires companies to perform hazard assessments for each location, set up a prevention program, and draft an emergency response plan, all to be submitted as a combined Risk Management Plan in 1999. The rule will be effective 60 days after publication in the Federal Register. The rulemaking began in 1993, after the Sierra Club won a settlement to compel the EPA to issue rules based on prior CAA amendments. The final rule was first released for comment in January 1994. EPA intends to send out training packets and is planning a series of workshops around the country.

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TABLE 1
SALIENT AMMONIA STATISTICS 1/ 2/

(Thousand metric tons of contained nitrogen unless otherwise specified)

	1991	1992	1993	1994	1995 p/
United States:					
Production	12,800	13,400	12,600	13,400	13,300
Exports	580	354	378	215	319
Imports for consumption	2,740	2,690	2,660	3,450	2,630
Consumption, apparent 3/	14,800	15,600	15,100	16,500	15,600
Stocks, Dec. 31; producers'	936	1,060	852	956	963
Average annual price per ton product, f.o.b. gulf coast 4/	$117	$106	$121	$211	$191
Net import reliance 5/ as a percent of apparent consumption	14	14	17	19	15
Natural gas price; wellhead 6/	$1.64	$1.74	$2.03	$1.88 r/	$1.59
World:					
Production	93,800	93,600	91,900 r/	90,800 r/	91,600 e/
Trade 7/	9,590	9,270	9,060 r/	10,000	10,800

e/ Estimated. p/ Preliminary. r/ Revised.
1/ Data are rounded 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)

	1994	1995 p/
Anhydrous ammonia, synthetic: 2/		
Fertilizer	11,600	11,600
Nonfertilizer	1,750	1,730
Total	13,400	13,300

p/ Preliminary.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Current Industrial Reports, MA28B, M28B, and MQ28B Bureau of the Census.

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

(Thousand metric tons)

Compound	1994	1995 p/
Urea:		
Gross weight	7,230 r/	7,090
Nitrogen content	3,330 r/	3,260
Ammonium nitrate:		
Gross weight	7,740 r/	8,010
Nitrogen content	2,710 r/	2,800
Ammonium phosphates: 3/		
Gross weight	15,600 r/	16,800
Nitrogen content	2,660	2,860
Ammonium sulfate: 4/		
Gross weight	2,350 r/	2,310
Nitrogen content	495 r/	486
Nitric acid, direct use: 5/		
Gross weight	1,710	1,840
Nitrogen content	381	430
Acrylonitrile:		
Gross weight	1,350 r/	1,450
Nitrogen content	365 r/	390
Caprolactam:		
Gross weight	685 r/	714
Nitrogen content	89 r/	93
Total:		
Gross weight	36,700 r/	38,200
Nitrogen content	10,000 r/	10,500

p/ Preliminary. r/ Revised.

1/ Data are rounded 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 1995 1/

(Thousand metric tons per year of ammonia)

Company	Location	Capacity 2/
Agrium Inc.	Borger, TX	439
Air Products and Chemicals Inc. 3/	New Orleans, LA	--
Do.	Pace Junction, FL	46
Allied Signal Inc.	Hopewell, VA	409
Arcadian Corp.	Augusta, GA	529
Do.	Clinton, IA	237
Do.	Geismar, LA	501
Do.	LaPlatte, NE	182
Do.	Lima, OH	523
Do.	Woodstock, TN	356
Avondale Ammonia 4/	Fortier, LA	387
Borden Chemicals Inc.	Geismar, LA	364
Carbonaire Co. Inc. 5/	Palmerton, PA	--
CF Industries Inc.	Donaldsonville, LA	1,740
Chevron Chemical Co.	El Segundo, CA	19
Do.	St. Helens, OR 6/	85
Coastal Chem, Inc.	Cheyenne, WY	172
Dakota Gasification Co.	Beulah, ND	22
E. I. du Pont de Nemours & Co. Inc.	Beaumont, TX	433
Farmland Industries Inc.	Beatrice, NE	255
Do.	Dodge City, KS	255
Do.	Enid, OK	919
Do.	Fort Dodge, IA	241
Do.	Lawrence, KS	409
Do.	Pollock, LA	459
First Mississippi (Ampro) Fertilizer Inc.	Donaldsonville, LA	557
Green Valley Chemical Corp.	Creston, IA	32
IMC-Agrico Co.	Faustina (Donaldsonville), LA	482
J. R. Simplot Co.	Pocatello, ID	93
Koch Industries	Sterlington, LA	1,110
LaRoche Industries Inc.	Cherokee, AL	159
Mississippi Chemical Corp.	Yazoo City, MS	455
Monsanto Co.	Luling, LA	446
Nitromite Fertilizer	Dumas, TX	128
Phoenix Chemical Co.	East Dubuque, IL	269
PPG Industries Inc. 7/	Natrium, WV	--
Shoreline Chemical	Gordon, GA	31
Terra International, Inc.	Blytheville, AR 8/	364
Do.	Port Neal, IA	319
Do.	Verdigris, OK 8/	955
Do.	Woodward, OK	446
Triad Chemical Co. 9/	Donaldsonville, LA	409
Union Chemical Co. (Unocal)	Finley, WA	150
Do.	Kenai, AK	1,140
Wil-Grow Fertilizer Co.	Pryor, OK	86
Total		16,600

1/ Data are rounded 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 late1994 to early1995.
4/ Joint venture between American Cyanamid and LaRoche Industries Inc. formed in 1994.
5/ Closed in 1993.
6/ Change in ownership; sold.
7/ Closed in 1994.
8/ Former Agricutural Minerals (AMC) plants sold to Terra International, Inc. in 1994.
9/ Joint venture between First Mississippi (Ampro) Fertilizer Inc. and Mississippi Chemical Corp.

Sources: International Fertilizer Development Center (IFDC); North American Fertilizer Capacity, Ammonia, Apr. 1996. Blue, Johnson and Associates, North American NPK Plants and Capacities, Foster City, CA.

TABLE 5
U.S. NITROGEN FERTILIZER CONSUMPTION,
BY PRODUCT TYPE 1/ 2/

(Thousand metric tons nitrogen)

Fertilizer material 3/	1994	1995 p/
Single-nutrient:		
Anhydrous ammonia	4,120	3,240
Nitrogen solutions 4/	2,420	2,520
Urea	1,680	1,680
Ammonium nitrate	609	583
Ammonium sulfate	180	192
Aqua ammonia	78	72
Other 5/	221	236
Total	9,310	8,530
Multiple-nutrient 6/	2,380 r/	2,360
Grand total	11,700 r/	10,900

p/ Preliminary. r/ Revised.

1/ Data are rounded 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. 1995.

TABLE 6
U.S. PRODUCER STOCKS OF
FIXED NITROGEN COMPOUNDS
AT YEAREND 1/ 2/

(Thousand metric tons nitrogen)

Material 3/	1994	1995 p/
Ammonia	956	1,170
Nitrogen solutions 4/	295	214
Urea	175	330
Ammonium nitrate	90	184
Ammonium phosphates 5/	87	67
Ammonium sulfate	48	260
Total	1,650	2,230

p/ Preliminary.

1/ Data are rounded 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 7
PRICE QUOTATIONS FOR MAJOR NITROGEN COMPOUNDS
AT YEAREND

(Per metric ton product)

Compound	1994	1995
Ammonium nitrate; f.o.b. Corn Belt 1/	$165-$176	$162-$170
Ammonium sulfate; f.o.b. Corn Belt 1/	125-149	124-136
Anhydrous ammonia:		
F.o.b. Corn Belt	254-265	205-220
F.o.b. gulf coast 2/	240-254	185-195
Diammonium phosphate; f.o.b. central Florida	184-190	212-215
Urea:		
F.o.b. Corn Belt, prilled	204-215	220-235
F.o.b. gulf coast, granular 2/	219-226	217-222
F.o.b. gulf coast, prilled 2/	204-213	217-220

1/ Illinois, Indiana, Iowa, Missouri, Nebraska, and Ohio.
2/ Barge, New Orleans.

Source: Green Markets, Fertilizer Market Intelligence Weekly, Dec. 18, 1995 and Jan. 1, 1996.

TABLE 8
U.S. EXPORTS OF ANHYDROUS AMMONIA, BY COUNTRY 1/

(Thousand metric tons ammonia)

Country	1994	1995 p/
Korea, Republic of	201	321
Brazil	NA	19
Taiwan	1	14
Costa Rica	(2/)	11
Canada	2	8
Mexico	27	3
Australia	25	--
China	1	(2/)
Jamaica	1	(2/)
South Africa	--	(2/)
Suriname	1	(2/)
Other 3/	2	3
Total 4/	261	387

p/ Preliminary. NA Not available.
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.
4/ Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census.

TABLE 9
U.S. IMPORTS OF ANHYDROUS AMMONIA, BY COUNTRY AND REGION 1/

(Thousand metric tons ammonia and thousand dollars)

Country or Region 2/	1994		1995 p/	
	Gross weight	Value 3/	Gross weight	Value 3/
Trinidad and Tobago	1,380	252,000	1,520	331,000
Canada	1,130	161,000	1,150	181,000
Russia	783 4/	145,000 4/	NA	179,000
Ukraine 5/	NA	NA	NA	70,700
Mexico	526	93,200	252	53,000
Latvia	70	15,200	101	24,300
Venezuela	78	14,000	74	15,800
Middle East 6/	138	27,800	36	8,730
West Europe 7/	38	8,040	36	9,070
Algeria	12	2,760	9	1,810
Japan	(8/)	27	2	151
Total	4,200	725,000	3,200	877,000

p/ Preliminary. NA Not available.
1/ Data are rounded 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 republic of the former U.S.S.R., effective Jan. 1992, included Ukraine.
5/ Independent republic of the former U.S.S.R., effective Jan. 1992.
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. Geological Survey.

TABLE 10
U.S. EXPORTS OF MAJOR NITROGEN COMPOUNDS IN 1995 1/

(Thousand metric tons and thousand dollars)

Compound	1994			1995 p/		
	Gross weight	Nitrogen content	Value	Gross weight	Nitrogen content	Value
Fertilizer materials:						
Ammonium nitrate 2/	55	18	NA	90	30	NA
Ammonium sulfate 2/	762	160	NA	917	193	NA
Anhydrous ammonia	261	215	NA	387	319	NA
Diammonium phosphate	9,190	1,660	NA	10,100	1,810	NA
Monoammonium phosphate	1,480	162	NA	1,200	145	NA
Urea	912	419	NA	881	406	NA
Mixed chemical fertilizers 3/	387	61	NA	295	47	NA
Total	13,000 r/	2,700 r/	NA	13,800	2,950	NA

p/ Preliminary. r/ Revised. NA Not available.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Includes industrial chemical products.
3/ Harmonized codes 3105.10.0000 and 3105.20.0000.

Source: Bureau of the Census.

TABLE 11
U.S. IMPORTS OF MAJOR NITROGEN COMPOUNDS IN 1995 1/

(Thousand metric tons and thousand dollars)

Compound	1994			1995 p/		
	Gross weight	Nitrogen content	Value 2/	Gross weight	Nitrogen content	Value 2/
Fertilizer materials:						
Ammonium nitrate 3/	612	205	74,000	721	245	103,000
Ammonium nitrate-limestone mixtures	41	11	5,190	74	20	9,340
Ammonium sulfate 3/	455	95	38,000	434	91	40,700
Anhydrous ammonia 4/	4,200	3,450	725,000	3,200	2,630	877,000
Calcium nitrate	(5/)	(5/)	13,800	NA	NA	NA
Diammonium phosphate	15	3	4,270	21	4	6,010
Monoammonium phosphate	203	23	41,400	NA	NA	NA
Nitrogen solutions	312	93	31,500	628	189	83,000
Potassium nitrate	16	2	5,240	NA	NA	NA
Potassium nitrate-sodium nitrate mixtures	45	7	6,810	NA	NA	NA
Sodium nitrate	98	15	15,700	NA	NA	NA
Urea	3,160	1,450	436,000	2,940	1,350	487,000
Mixed chemical fertilizers 6/	212	25	33,000	NA	NA	NA
Other ammonium phosphates 7/	211	34	25,100	NA	NA	NA
Other nitrogenous fertilizers 8/	145	28	25,500	NA	NA	NA
Total	9,730	5,450	1,480,000	8,010	4,900	1,610,000

p/ Preliminary. NA Not available.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Import values c.i.f.
3/ Includes industrial chemical products.
4/ Includes industrial ammonia.
5/ Less than 1/2 unit.
6/ Harmonized codes 3105.10.0000 and 3105.20.0000.
7/ Codes 3105.51.0000, 3105.59.0000, and 3105.40.0050.
8/ Codes 3101.00.0000, 3102.29.0000, 3102.60.0000, 3102.90.0000, and 3105.90.0050.

Source: Bureau of the Census.

TABLE 12
AMMONIA: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Thousand metric tons of contained nitrogen)

Country	1991	1992	1993	1994	1995 e/
Afghanistan e/	40	40	30	30	30
Albania e/	80	15	15	15	15
Algeria	269	438	380	380 r/	380
Argentina	75	72	72	72 e/	70
Australia	414	392 r/	398	413 r/	433 3/
Austria e/	400	400	400	400	400
Bahrain	320	323	348	338	358 3/
Bangladesh 4/	667	937	991	995 e/	975
Belarus	XX	916	619	500 e/	500
Belgium	272	514	535	500 e/	500
Bosnia and Herzegovina e/	XX	5	2	1	1
Brazil e/	940	940	940 r/	940	940
Bulgaria	1,093	905	885 r/	800 e/	800
Burma e/	111 3/	110	110	130	130
Canada	3,016	3,104	3,410	3,470	3,500
China e/	18,000	18,000	19,000	19,000	19,500
Colombia e/	92	86	99	90	90
Croatia e/	XX	300	300	300	300
Cuba e/	140	135	135	130	130
Czech Republic	XX	XX	149	150 e/	150
Czechoslovakia 5/	551	385 e/	XX	XX	XX
Egypt	863	943	941	940 e/	940
Estonia	XX	115	45	45 e/	45
Finland e/	24 3/	10	10	10	10
France	1,604	1,848	1,871	1,480 r/	1,500
Germany	2,123	2,113	2,100	2,170 r/	2,100

See footnotes at end of table.

TABLE 12--Continued
AMMONIA: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Thousand metric tons of contained nitrogen)

Country	1991	1992	1993	1994	1995 e/
Georgia	XX	96	58	35 e/	30
Greece	210	140	57	55 e/	55
Hungary	261	152	237	230 e/	230
Iceland	8	9	9 e/	9	9
India 6/	7,132	7,452	7,176 r/	7,334 r/	7,713 3/
Indonesia	2,706	2,688	2,888	2,800 e/	2,850
Iran	468	664	723	696	700
Iraq e/	40	200	500	500	500
Ireland	429	384	367	380 e/	370
Israel 4/	35	37	41	41 e/	41
Italy	1,147	1,100 e/	729	504 r/	600
Japan	1,553	1,602	1,447	1,450 e/	1,400
Kazakstan	XX	220	231	200 e/	200
Korea, North e/	550	550	600	600	600
Korea, Republic of	407	442	450 e/	460 e/	470
Kuwait	--	140	320	325 e/	325
Libya e/	200	200	200	200	200
Lithuania	XX	275	275 r/ e/	277 r/	442 3/
Malaysia	286	331	334	334 e/	340
Mexico	2,221	2,203	1,758	2,030	2,100
Netherlands	3,033	2,588	2,472	2,500 e/	2,500
New Zealand	70 e/	68	78	78 e/	80
Nigeria	367	337 r/	350 e/	350 e/	350
Norway	384	343	315	270 r/	300
Pakistan	1,154	1,144	1,446	1,450 e/	1,450
Peru e/	95	90	90	90	90
Poland	1,531	1,490	1,419	1,500	1,500
Portugal	198	100	91	100 e/	100
Qatar	569	622	628 r/	640 r/	650
Romania	1,128	1,421	1,328 r/	-- r/	1
Russia	XX	8,786	8,138	7,500 e/	7,500
Saudi Arabia	827	904	1,097	1,900 r/	2,000
Serbia and Montenegro	XX	148	100	159 r/	150
Slovakia	XX	XX	263	250 e/	250
South Africa	457	541	607	600 e/	600
Spain	557	479	354	360 e/	360
Switzerland	33	31	28	30 e/	30
Syria	17	81	67	67 r/	67
Taiwan	243 r/	224	220	215	226 3/
Tajikistan e/	XX	50	40	30	25
Trinidad and Tobago	1,595	1,568	1,462	1,649 r/	1,696 3/
Turkey	357 r/	344 r/	326	350 e/	350
Turkmenistan	XX	25	32	25 e/	25
U.S.S.R. 7/	17,100	XX	XX	XX	XX
Ukraine	XX	3,908	3,242	2,500 e/	2,200
United Arab Emirates	286	275	288	243 r/	250
United Kingdom	1,011	869	873	1,006 r/	1,000
United States 8/	12,800	13,400	12,600	13,400	13,300 3/
Uzbekistan	XX	1,309	1,105	1,100 e/	1,100
Venezuela	450	404	535	505	600 3/
Vietnam e/	30	45	52 3/	53	52
Yugoslavia 9/	700 e/	XX	XX	XX	XX
Zambia	5	7 e/	10	10 e/	10
Zimbabwe e/	66	67	70	70	70
Total	93,800	93,600	91,900 r/	90,800 r/	91,600

e/ Estimated. r/ Revised. XX Not applicable.

1/ World totals, U.S. data and estimated data are rounded to three significant digits; may not add to totals shown.

2/ Table includes data available through June 21, 1996.

3/ Reported figure.

4/ May include nitrogen content of urea.

5/ Dissolved Dec. 31, 1992.

6/ Data are for years beginning Apr. 1 of that stated.

7/ Dissolved in Dec. 1991.

8/ Synthetic anhydrous ammonia; excludes coke oven byproduct ammonia.

9/ Dissolved in Apr. 1992.