



Project Summary

Ammonia Emission Factors for the NAPAP Emission Inventory

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This report was prepared for the National Acid Precipitation Assessment Program (NAPAP) to provide information on certain sources of ammonia emissions to the atmosphere for use in NAPAP emission inventories. Major anthropogenic sources of ammonia emissions to the atmosphere are identified, and emission factors for these sources are presented based on a review of the most recent data available. The emission factors developed are used to estimate nationwide emissions for base year 1980 and are compared to ammonia emission factors used in other emission inventories. Major anthropogenic source categories covered are cropland spreading of livestock wastes, beef cattle feedlots, fertilizer manufacture and use, fuel combustion, ammonia synthesis, petroleum refineries, and coke manufacture. Approximately 840,000 tons* of ammonia are estimated to have been emitted in the U.S. in 1980, over 64% of which is estimated to have been from livestock wastes.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

*Certain nonmetric units are used in this Summary for convenience. Readers more familiar with metric units may use the following to convert to that system: 1 bbl = 158.99 liters, 1 ft³ = 28.32 liters, 1 gal. = 3.79 liters, 1 lb = 0.45 kg, and 1 ton = 907.19 kg.

Introduction

The focus of emission inventory activities within the National Acid Precipitation Assessment Program (NAPAP) is to estimate emissions of compounds believed to be involved in the acid deposition process. Ammonia (NH₃) has been identified as a compound that plays a role in atmospheric chemistry relating to acid deposition. This document summarizes the results of a preliminary effort to gather data available for estimating ammonia emissions from significant anthropogenic sources of the compound. The purpose of this effort is to provide the NAPAP Emission Inventory with information for estimating ammonia emissions for base year 1980 and to identify areas where better data are needed.

Because of the limited amount of data available on ammonia emissions and because of the difficulty in estimating emissions from area sources such as livestock wastes, this document should be considered a first step in developing a complete and accurate ammonia emissions inventory. The reader is cautioned against using the emissions information contained in this document to try to develop an exact assessment of emissions from any particular facility or location. It is possible, in some cases, that order-of-magnitude differences could exist between actual and calculated emissions, depending on differences in source configurations, control equipment, and operating practices.

Approach

The approach used in developing these emission factors began with a lit-

erature search to identify potential emission source categories and to narrow these to major emitters (sources over 100 tons NH₃/year). Eight major source categories were identified as a result of this effort: (1) beef cattle feedlots, (2) collection of livestock wastes from confined areas and subsequent application to cropland, (3) fossil fuel combustion, (4) fertilizer manufacture, (5) application of anhydrous ammonia to cropland, (6) petroleum refineries, (7) ammonia synthesis, and (8) coke manufacture.

Potentially significant source categories not included in this document and not currently included in NAPAP's natural sources program are wastewater treatment, range and wild animal excrement, cigarette smoking, forest fires, and human breath and perspiration. Further investigation of these sources should be conducted for the NAPAP Emission Inventory for the 1985 base year. Source categories eliminated from the study because of estimated emissions under 100 tons/year or because of a lack of data include cement manufacture, sodium carbonate manufacture, open burning of wood waste, coal refuse piles, and manufacture of a number of synthetic chemicals including fumaric acid, melamine, aniline, and nitroaniline.

After identifying major emission categories, the next step was to determine an appropriate emission factor for each source category. When available, emission factors based on actual emission tests were chosen. Emission factors were evaluated using a methodology analogous to the AP-42 rating system. Factors were rated on a scale of A through E, with A representing data from a large data base covering a good cross section of the industry, and with a high confidence level. Data rated E were developed from a small data base, not necessarily representative of the industry, and with a low confidence level. Ratings of B through D represent data with intermediate confidence levels. Emission factors and associated ratings are listed in Table 1.

The emission factors and associated 1980 national emission estimates for each category covered by this report are shown in Table 1. The emission estimates presented were calculated by multiplying an assumed level of activity (e.g., production/use rates) for each source category in 1980 by the emission factor for that source category. Activity levels used to estimate nationwide

emission in the 1980 NAPAP database were derived from those in the National Emissions Data System (NEDS). Based on the emission factors chosen and the activity levels assumed for each source category, it is estimated that approximately 840,000 tons of ammonia was emitted in 1980 from the sources listed in Table 1. Over 64% of the total is estimated to have been emitted from sources in the livestock waste management category.

There are several reasons for the deficiencies encountered in the ammonia database. One reason is the lack of a standardized test method for ammonia. Several methods of sampling and analysis were identified in the gathering of data contained in this document. However, none of these have been endorsed by EPA as a standard for ammonia, and there appears to be no consensus on which of these methods is the most reliable. Another reason for data deficiencies is the fact that several of the major sources are area sources which are particularly difficult to characterize. Also, no federal mandate exists for gathering ammonia emissions data, as there is for criteria pollutants and other hazardous compounds. And finally, much of the data that currently exist were gathered during research projects under conditions which are not representative of those found in actual working environments.

Conclusions

Several conclusions resulted from this effort.

- The largest anthropogenic source categories of ammonia are livestock waste management (64%), and fertilizer production (27%).
- Source test data gathered by reliable test methods for likely operating conditions are needed to better characterize ammonia emissions from several source categories: livestock waste management, ammonium nitrate manufacture, fertilizer application, fossil fuel combustion, and coke manufacture.
- Several source categories should be investigated for possible inclusion in the NAPAP Emission Inventory for the 1985 base year: wastewater treatment, range and wild animal excrement, cigarette smoking, forest fires, human breath and perspiration, and natural sources.

Table 1. Ammonia Emission Estimates for the 1980 NAPAP Emissions Inventory

Source	Emission factor	Emissions ^a (tons/yr)	Emission factor rating
Livestock Waste Management			
Beef cattle feedlots	13 lb/animal	150,000	E
Cropland spreading			
beef cattle	1.8 lb/animal	97,000	E
dairy cows	26 lb/animal	130,000	E
swine	3.1 lb/animal	98,000	E
sheep	2.0 lb/animal	NA	E
laying hens	0.19 lb/animal	21,000	E
broilers	0.024 lb/animal	45,000	E
turkeys	0.16 lb/animal	NA	E
Combustion Sources			
Coal	0.00056 lb/ton coal ^b	180	E
Fuel oil	0.8 lb/10 ³ gal. fuel ^b	c	E
Natural gas			
utility boilers	3.2 lb/10 ⁶ ft ³ gas ^b	c	C
industrial boilers	3.2 lb/10 ⁶ ft ³ gas ^b	c	C
commercial boilers	0.49 lb/10 ⁶ ft ³ gas ^b	c	C
Mobile sources			
leaded gasoline	0.42 lb/10 ³ gal. fuel ^b	d	D
unleaded gasoline	0.63 lb/10 ³ gal. fuel ^b	d	D
diesel	0.95 lb/10 ³ gal. fuel ^b	d	E
Ammonium Nitrate Manufacture			
Neutralizer	*18 lb/ton ^e	36,000	D ^e
Solids formation			
evaporation/concentration	*17 lb/ton ^{e,f}	12,000	D ^e
high density prill towers	*57.2 lb/ton ^f	130,000	A
low density prill towers	* 0.26 lb/ton ^f	67	A
granulators	*50 lb/ton ^{e,f}	47,000	D ^e
high density prill coolers	* 0.04 lb/ton ^f	9	A
low density prill coolers	* 0.30 lb/ton ^f	NA	A
low density prill dryers	* 1.6 lb/ton ^{e,f}	NA	D ^e
granulator coolers	* 1 lb/ton ^{e,f}	620	D ^e
Anhydrous Ammonia Fertilizer			
Application	19 lb/ton fertilizer	50,000	C
Petroleum Refineries			
FCC units	*54 lb/10 ³ bbl feed ^g	8,400	B
TCC units	* 6 lb/10 ³ bbl feed ^g	87	B
Reciprocating engine compressors	* 0.2 lb/10 ³ ft ³ gas ^b	NA	B
Ammonia Synthesis			
Carbon dioxide regeneration	* 2.0 lb/ton ^f	1,500	A
Condensate stripping	* 2.2 lb/ton ^f	1,600	A
Urea Manufacture			
Solution formation/concentration			
Solid formation	*18.2 lb/ton ^f	NA	A
Solid formation			
nonfluidized bed prilling			
agricultural grade	* 0.87 lb/ton ^f	NA	A
fluidized bed prilling			
agricultural grade	* 2.9 lb/ton ^f	NA	A
feed grade	* 4.1 lb/ton ^f	NA	A
drum granulation	* 2.2 lb/ton ^f	NA	A
rotary drum cooler	* 0.0051 lb/ton ^f	NA	A
Coke Manufacture			
Oven charging	* 0.02 lb/ton coal charged	480	D
Door leaks	* 0.06 lb/ton coal charged	710	D
Coke pushing	* 0.1 lb/ton coal charged	1,400	D
Quenching (contaminated water)	0.28 lb/ton coal charged	4,700	D

Table 1. Ammonia Emission Estimates for the 1980 NAPAP Emissions Inventory—Continued

Source	Emission factor	Emissions ^a (tons/yr)	Emission factor rating
Ammonium Phosphate Manufacture	* 0.14 lb/ton ^f	770	A
Minor Point Sources	NA	3,800	—
TOTAL		840,000	—

^aEmission estimates are for 1980.

^bPounds of ammonia emitted per unit of fuel burned.

^cNEDS activity levels for fossil fuel combustion sources were not applied to the related emission factors in the Emissions Inventory System. Therefore, emission estimates for these sources categories were not included in the 1980 NAPAP Emissions Inventory.

^dNEDS activity levels for mobile sources were not applied to the related emission factors in the Emissions Inventory System. Therefore, emission estimates for these source categories were not included in the 1980 NAPAP Emission Inventory.

^eEmission factor is from midpoint of range reported in AP-42. Associated rating is lower than that reported in AP-42 because of the listing of a single factor rather than a range (as in AP-42).

^fPounds of ammonia emitted per ton of product.

^gPounds of ammonia emitted per 10³ barrels of feed to the cracking unit.

*- Emission factor and associated factor rating is from AP-42.

NA - Not available.

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The complete report, entitled "Ammonia Emission Factors for the NAPAP Emission Inventory," (Order No. PB 87-152 336/AS; Cost: \$13.95, subject to change) will be available only from:

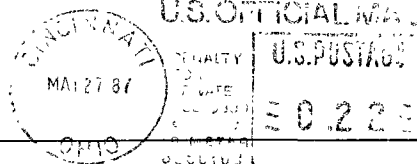
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