

## Multilateral Investment Guarantee Agency

### Environmental Guidelines for

# Mixed Fertilizer Plants

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### Industry Description and Practices

Mixed fertilizers contain two or more of the elements nitrogen, phosphorous and potassium that are essential for good plant growth and greater crop yields. This document addresses the production of ammonium phosphates (monoammonium phosphate--MAP, and diammonium phosphate--DAP), nitrophosphates, potash (potassium chloride), and compound fertilizers.

Ammonium phosphates are produced by mixing phosphoric acid and anhydrous ammonia in a reactor to produce a slurry (mixed acid route leading to fertilizers NPK fertilizers – potassium and other salts are added during the process). The slurry is then sprayed onto a bed of recycled solids in a rotating granulator and ammonia is sparged into the bed from underneath. Granules pass to a rotary dryer followed by a rotary cooler. Solids are screened and sent to storage for bagging and/or for bulk shipment.

Nitrophosphate fertilizer is made by digesting phosphate rock with nitric acid (nitrophosphate route leading to NPK fertilizers – as in the mixed acid route potassium and other salts are added during the process) The resulting solution is cooled to precipitate calcium nitrate which is removed by filtration. The filtrate is neutralized with ammonia and the solution is then evaporated to reduce the water content. Prilling may follow. The calcium nitrate filter cake can be further treated to produce a calcium nitrate fertilizer, pure calcium nitrate, or to give ammonium nitrate and calcium carbonate. Nitrophosphate fertilizers are also produced by the mixed-acid

process – digestion of the phosphate rock by a mixture of nitric and phosphoric acids.

Potash (potassium carbonate) or potassium chloride (sylvine), is solution mined from deposits and is refined through crystallization processes to produce the fertilizer. Potash may also be dry mined and purified by flotation.

Compound fertilizers can be made by blending basic fertilizers such as ammonium nitrate, MAP, DAP, and granular potash which may involve a granulation process.

### Waste Characteristics

#### *Air Emissions*

The principal pollutants from the production of MAP and DAP are ammonia and fluorides that are given off in the steam from the reaction. Fluorides and dust are released from material handling operations. Ammonia in uncontrolled air emissions has been reported to range 0.1-7.8 kilograms of nitrogen per metric ton (kg/t) of product, with phosphorous ranging 0.02-2.5 kg/t product (as P<sub>2</sub>O<sub>5</sub>) and fluorides ranging 0.01-0.4 kg/t product (as P<sub>2</sub>O<sub>5</sub>).

In nitrophosphate production, dust will also contain fluorides. Oxides of nitrogen are also given off at the digester. In the evaporation stage fluorine compounds and ammonia are released. Unabated emissions for nitrogen oxides (NO<sub>x</sub>) from selected processes are given as: >1000 milligrams per cubic meter (mg/m<sup>3</sup>) for digestion of phosphate rock with nitric acid; 50-200 mg/m<sup>3</sup> from neutralization with ammonia; and 30-200 mg/m<sup>3</sup> from granulation and drying.

Dust is the primary air pollutant from potash manufacturing.

### Liquid Effluents

The volumes of liquid effluents from mixed fertilizer plants are reported to range 1.4 -50 cubic meters per metric ton of product (m<sup>3</sup>/t) product. Where water is used in scrubbers, the scrubbing liquors can usually be returned to the process. Effluents can contain nitrogen, phosphorous, and fluorine and concentrations can range 0.7-15.7 kg/t product (as N), 0.1-7.8 kg/t product (as P<sub>2</sub>O<sub>5</sub>), and 0.1-3.2 kg/t product (as P<sub>2</sub>O<sub>5</sub>).

### Solid Wastes

Generally, there is little solid waste from a fertilizer plant since dust and fertilizer spillage can be returned to the process.

## Pollution Prevention and Control

Material handling and milling of phosphate rock should be carried out in closed buildings. Fugitive emissions can be controlled by, for example, hoods on conveying equipment with capture of the dust in fabric filters.

In the ammonium phosphate plant, pass the gas streams from the reactor, granulator, dryer, and cooler through cyclones and scrubbers (using phosphoric acid as the scrubbing liquid) to recover particulates, ammonia, and other materials for recycling.

In the nitrophosphate plant, prevent NO<sub>x</sub> emissions by the addition of urea to the digestion stage. Prevent fluoride emissions by scrubbing the gases with water. Remove ammonia by scrubbing. Phosphoric acid may be used for scrubbing where the ammonia load is high. Balance the process water system, if necessary by the use of holding tanks, to avoid the discharge of an effluent.

## Treatment Technologies

Additional pollution control devices beyond the scrubbers, cyclones, and baghouses that are an integral part of the plant design and operations are generally not required for mixed fertilizer

plants. Good housekeeping practices are essential to minimize the amount of spilled material. Spills or leaks of both solids and liquids should be returned to the process. Liquid effluents, if any, need to be controlled for total suspended solids, fluorides, phosphorous, and ammonia.

Modern plants using good industrial practices are able to achieve the following in terms of pollutant loads:

### Air Emissions

The following emissions values have been reported for the manufacture of NPK fertilizers by the nitrophosphate route and should be attained in a well operated plant:

Parameter	Loading
Ammonia (NH <sub>3</sub> as N)	0.3 kg/t NPK produced
NO <sub>x</sub> (as nitrogen dioxide -- NO <sub>2</sub> )	0.2 kg/t NPK produced
Fluoride (as F)	0.02 kg/t NPK produced
Particulates	0.3 kg/t NPK produced

Where NPK fertilizers are produced by the mixed acid route the following emissions loadings are attainable:

Parameter	Loading <sup>1</sup>
Ammonia nitrogen (NH <sub>4</sub> -N -- including free ammonia)	0.01 kg/t NPK produced
Fluoride (as F)	0.01 kg/t NPK produced
Particulates	0.2 kg/t NPK produced

<sup>1</sup> Loadings can range widely depending on the grade of fertilizer produced.

### Liquid Effluents

An effluent discharge of less than 1.5 m<sup>3</sup>/t product as P<sub>2</sub>O<sub>5</sub> is realistic however by using holding ponds a discharge approaching zero may be feasible. Pollutant loads in effluents are reported as follows for NPK fertilizers by the nitrophosphate route:

Parameter	Loading <sup>1</sup>
P <sub>2</sub> O <sub>5</sub>	0.06 kg/t NPK produced
NH <sub>4</sub> -N	0.012 kg/t NPK produced
Nitrate nitrogen (NO <sub>3</sub> -N)	0.03 kg/t NPK produced
Fluoride (F)	0.05 kg/t NPK produced

### Emission Guidelines

Emission levels for the design and operation of each project must be established through the Environmental Assessment (EA) process, based on country legislation and the *Pollution Prevention and Abatement Handbook* as applied to local conditions. The emission levels selected must be justified in the EA and acceptable to MIGA.

The following guidelines present emission levels normally acceptable to the World Bank Group in making decisions regarding provision of World Bank Group assistance, including MIGA guarantees; any deviations from these levels must be described in the project documentation.

The guidelines are expressed as concentrations to facilitate monitoring. Dilution of air emissions or effluents to achieve these guidelines is unacceptable.

All of the maximum levels should be achieved for at least 95% of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours.

### Air Emissions

For mixed fertilizer plants, the following emissions levels should be achieved:

#### Air Emissions from Mixed Fertilizer Plants

Parameter	Maximum value milligrams per normal cubic meter (mg/Nm <sup>3</sup> )
Particulate matter (PM)	50
Ammonia (NH <sub>3</sub> as N)	50
Fluorides (as F)	5
Nitrogen oxides (as NO <sub>2</sub> ) <sup>1</sup>	500 70

<sup>1</sup> Higher value is for nitrophosphate unit; lower value is for mixed acid unit

### Liquid Effluents

For mixed fertilizer plants, the following effluent levels should be achieved:

#### Effluents from Mixed Fertilizer Plants

Parameter	Maximum value milligrams per liter (mg/L)
pH	6 - 9
Total suspended solids	50
Fluorides (F)	20
Total metals	10
Cadmium	0.1
Phosphorous (as P)	5
Ammonia (NH <sub>4</sub> -N)	10

Note: Effluent requirements are for direct discharge to surface waters.

Note: Waste water treatment discharges are sometimes used for agricultural purposes and may contain heavy metals. Of particular concern is the cadmium content.

### Ambient Noise

Noise abatement measures should achieve either the following levels or a maximum

increase in background levels of 3 dB(A). Measurements are to be taken at noise receptors located outside the project property boundary.

### Ambient Noise

Receptor	Maximum Allowable $L_{eq}$ (hourly), in dB(A)	
	Daytime 07:00 - 22:00	Nighttime 22:00 - 07:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

The emission requirements given here can be consistently achieved by well-designed, well-operated and well-maintained pollution control systems.

### Monitoring and Reporting

Frequent sampling may be required during start-up and upset conditions. Once a record of consistent performance has been established, sampling for the parameters listed above should be as detailed below.

Air emissions at point of discharge are to be monitored continuously for fluorides and particulates and annually for ammonia and nitrogen oxides.

Liquid effluents should be continuously monitored for pH. Other parameters are to be monitored at least weekly.

Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Records of monitoring results should be kept in an acceptable format. These should be reported to the responsible authorities and relevant parties, as required, and provided to MIGA if requested.

### Key Issues

The following box summarizes the key production and control practices that will lead to compliance with emission requirements:

- Maximize product recovery and minimize air emissions by appropriate maintenance and operation of scrubbers and baghouses.
- Eliminate effluent discharges by operating a balanced process water system.
- Prepare and implement an Emergency Preparedness and Response Plan.\*
- An Emergency Preparedness and Response Plan is required for the plant because of the large quantities of ammonia and other hazardous materials stored and handled on site.

### Further Information

The following are suggested as sources of additional information (these sources are provided for guidance and are not intended to be comprehensive):

Bounicore, A.J. and W.T. Davis. 1992. *Air Pollution Engineering Manual*. New York: Van Nostrand Reinhold.

Sauchelli, Vincent. 1960. *Chemistry and Technology of Fertilizers*. New York: Reinhold Publishing Corporation.

Sittig, Marshall. 1979. *Fertilizer Industry; Processes, Pollution Control and Energy Conservation*. New Jersey: Noyes Data Corporation.

United Nations Industrial Development Organization (UNIDO). 1978. *Process Technologies for Nitrogen Fertilizers*. New York: United Nations.

UNIDO. 1978. *Process Technologies for Phosphate Fertilizers*. New York: United Nations.

World Bank, Environment Department. 1996. "Pollution Prevention and Abatement: Technical Background Document Mixed Fertilizer Plants."

European Fertilizer Manufacturers' Association, 1995. "Production of NPK Fertilizers by the Nitrophosphate Route". Booklet 7 of 8.

European Fertilizer Manufacturers' Association, 1995. "Production of NPK Fertilizers by the Mixed Acid Route". Booklet 8 of 8.