Multilateral Investment Guarantee Agency

Environmental Guidelines for

Phosphate Fertilizer Plants

Industry Description and Practices

Phosphate fertilizers are produced by adding acid to ground/pulverized phosphate rock. If sulfuric acid is used, then single or normal, phosphate (SSP) is produced having a phosphorous content of 16-21 percent as phosphorous pentoxide (P_2O_5). If phosphoric acid is used to acidulate the phosphate rock, then triple phosphate (TSP) is the result. TSP has a phosphorous content of 43-48 percent as P_2O_5.

SSP production involves mixing the sulfuric acid and the rock in a reactor followed by discharging the reaction mixture on to a slow moving conveyor in a den. It is cured for 4 to 6 weeks before bagging and shipping.

Two processes are used to produce TSP fertilizers: run-of-pile and granular. The run-of-pile process is similar to the SSP process. Granular TSP uses lower strength phosphoric acid (40 percent compared to 50 percent for run-of-pile). The reaction mixture as a slurry, is sprayed on to recycled fertilizer fines in a granulator. Granules grow and are then discharged to a dryer, screened and sent to storage.

Phosphate fertilizer complexes often have sulfuric and phosphoric acid production facilities. Sulfuric acid is produced by burning molten sulfur in air to produce sulfur dioxide which is then catalytically converted to sulfur trioxide for absorption in oleum. Sulfur dioxide can also be produced by roasting pyrites ore. Phosphoric acid is manufactured by adding sulfuric acid to phosphate rock. The reaction mixture is filtered to remove phosphogypsum, which is discharged to settling ponds or waste heaps.

Waste Characteristics

Fluorides and dust are emitted to air from the fertilizer plant. All aspects of phosphate rock processing and finished product handling generate dust, such as grinders/pulverizers, pneumatic conveyors, and screens. The mixer/reactors and dens produce fumes that contain silicon tetrafluoride and hydrogen fluoride. Liquid effluents are not normally expected from the fertilizer plant since it is feasible to operate the plant with a balanced process water system. The fertilizer plant should generate minimal solid wastes.

A sulfuric acid plant has two principal air emissions: sulfur dioxide and acid mist. If pyrites ore is roasted then there will also be particulates in air emissions which may contain heavy metals such as cadmium (Cd), mercury (Hg), and lead (Pb). Sulfuric acid plants do not normally discharge liquid effluents except where appropriate water management measures are absent. Solid wastes from a sulfuric acid plant will normally be limited to spent vanadium catalyst. Where pyrite ore is roasted, there will be pyrite residue which will require disposal. The residue may contain a wide range of heavy metals such as zinc, copper, lead, cadmium, mercury and arsenic.

The phosphoric acid plant generates dust and fumes, both of which contain hydrofluoric acid and/or silicon tetrafluoride.

Phosphogypsum generated in the process (at an approximate rate of about 5 t/t of phosphoric acid produced) is most often disposed as a slurry to a storage/settling pond or waste heap (disposal to a marine environment is practiced at some existing phosphoric acid plants).

Process water used to transport the waste is returned to the plant after the solids have settled out. It is preferable to have this as a closed loop operating system where possible to avoid a liquid effluent. In many climatic conditions, however, this is not possible and an effluent is generated. This effluent contains phosphorous (as PO_4), fluorides, and suspended solids. The phosphogypsum contains trace metals, fluorides, and radionuclides (especially radon gas) that have carried through from the phosphate rock.

Pollution Prevention and Control

In a fertilizer plant the major source of potential pollution is solids—from spills, operating upsets, and dust emissions. It is essential that tight operating procedures be in place, and that close attention be paid to constant cleanup of spills and other housecleaning measures. Product will be retained, the need for disposal of waste product will be controlled, and potential contamination of storm water runoff from the property will be minimized.

Minimize the discharge of sulfur dioxide from sulfuric acid plants by using the double contact double absorption process with high efficiency mist eliminators. Prevent spills and accidental discharges through well bunded storage tanks, through installing spill catchment and containment facilities, and through good housekeeping and maintenance practices. Residues from the roasting of pyrites may be used by the cement and steel manufacturing industries.

In the phosphoric acid plant, minimize emissions of fluorine compounds from the digester/reactor by scrubbers that are well-designed, well-operated, and well-maintained. Again, design for spill containment is essential to avoid inadvertent liquid discharges. Maintain an operating water balance to avoid an effluent discharge.

The management of phosphogypsum tailings is a major problem because of the large volumes and large area required, and the potential for release of dust and radon gases, and fluorides and cadmium in seepage. The following will help to minimize the impacts:

- Maintain a water cover to reduce radon gas release and dust emissions.
- Where water cover cannot be maintained, keep the tailings wet or revegetate to reduce dust. (The revegetation process, however, may increase the rate of radon emissions.)
- Line the tailings storage area to prevent contamination of groundwater by fluoride.
- Where contamination of groundwater is a concern, a management and monitoring plan should be implemented.

Phosphogypsum may find a use in the production of gypsum board for the construction industry.

Target Pollution Loads

Implementation of cleaner production processes and pollution prevention measures can provide both economic and environmental benefits. The following production-related targets can be achieved by measures such as those detailed in the previous section. The numbers relate to the production processes *before* the addition of pollution control measures.

In the sulfuric acid plant using the double contact, double absorption process, emission levels of 2-4 kilograms of sulfur dioxide per metric ton (kg/t) of sulfuric acid can be achieved, and sulfur trioxide levels in the order of 0.15-0.2 kg/t H_2SO_4 are attainable.

Treatment Technologies

Scrubbers are used to remove fluorides and acid from air emissions. The effluent from the scrubbers is normally recycled to the process. If it is not possible to maintain an operating water balance in the phosphoric acid plant, then treatment to precipitate fluorine, phosphorous, and heavy metals may be necessary. Lime can be used for treatment. Spent vanadium catalyst is returned to the supplier for recovery or, if unavailable, then locked in to a solidification matrix and disposed in a secure landfill.

There may be opportunities to use gypsum wastes as soil conditioner (for alkali soil and soils that are deficient in sulfur) and this should be explored so that the volume of the gypsum stack can be minimized.

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 phosphate fertilizer plants, the following emissions levels should be achieved:

Air Emissions from Phosphate Fertilizer Production

Pollutant	*Maximum value milligrams per normal cubic meter (mg/Nm^3)*
Fertilizer plant	
Fluorides (F)	5
Particulates	50
Sulfuric acid plant	
Sulfur dioxide (SO_2)	2 kg/t acid
Sulfur trioxide (SO_3)	0.15 kg/t acid
Phosphoric acid plant	
Fluorides (F)	5
Particulates	50

Liquid Effluents

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

Effluents from Phosphate Fertilizer Production

Pollutant	*Maximum value milligrams pe liter (mg/L)*
pH	6 - 9
Total suspended solids	50
Phosphorous (P)	5
Fluoride (F)	20
Cadmium (Cd)	0.1

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

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

	Maximum Allowable L_{eq} (hourly), in dB(A)	
Receptor	Daytime 07:00 - 22:00	Nightime 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

Fluoride and particulate emissions to the atmosphere from the fertilizer plant should be monitored continuously. In the sulfuric acid plant, sulfur dioxide and acid mist in the stack gas should be monitored continuously.

Liquid effluents should be monitored continuously for pH. All other parameters may be monitored on a monthly basis.

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.

For land storage of phosphogypsum, the following monitoring parameters and frequency are recommended for the stack drainage and runoff: continuously for pH; daily for fluorides; and monthly for phosphorous, sulfates, and gross alpha particle activity.

Key Issues

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

- Achieve the highest possible sulfur conversion rate and use the double contact double absorption process for sulfuric acid production.
- Consider the use of phosphogypsum to produce gypsum boards for the construction industry
- Design and operate phosphogypsum disposal facilities to minimize impacts.
- 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.*
- Consider providing pyrites roasting residues to cement and/or steel making industries

* An Emergency Preparedness and Response Plan is required for the plant because of the large quantities of sulfuric and phosphoric acids 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 Phosphate Fertilizers.* New York: United Nations.

World Bank, Environment Department. 1996. “Pollution Prevention and Abatement: Phosphate Fertilizer Plants.”

European Fertilizer Manufacturers' Association, 1995. "Production of Sulphuric Acid". Booklet 3 of 8.

European Fertilizer Manufacturers' Association, 1995. "Production of Phosphoric Acid". Booklet 4 of 8.