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Safety specifications for the production of phosgene and phosgenation products

光气及光气化产品生产安全规范

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Safety specifications for the production of phosgene and phosgenation products

1 Scope

This document specifies the planning, layout, design, production and operation, emergency response, safety requirements for phosgene and phosgenation product production facilities, as well as the production of phosgenation products using diphosgene and triphosgene.

This document applies to the production of phosgene and phosgenation products, as well as newly built, expanded, renovated, existing facilities producing phosgenation products using diphosgene and triphosgene.

2 Normative references

The contents of the following documents, through normative references, constitute essential provisions of this document. For dated references, only the version corresponding to that date applies to this document. For undated references, the latest version (including all amendments) applies to this document.

GB 2894 Safety signs and guideline for the use

GB 12158 General requirements for preventing electrostatic accidents

GB 16297 Integrated emission standard of air pollutants

GB 17945 Fire emergency lighting and evacuate indicating system

GB/T 20801 (all parts) Pressure piping code - Industrial piping

GB/T 29639 Guidelines for enterprises to develop emergency response plan for work place accidents

GB 30000.18 Rules for classification and labelling of chemicals - Part 18: Acute toxicity

GB 30077 Requirements on emergency rescue materials equipment for hazardous chemical enterprises

GB 31571 Emission standard of pollutants for petroleum chemistry industry

AQ 3009 Safety criterion for electrical apparatus in hazardous areas

AQ/T 3034 Guidelines for chemical process safety management

AQ 3047 The rule of precautionary label for chemicals in workplace

AQ 8001 General principle of safety assessment

SH/T 3097 Specification for design of static electricity earthing in petrochemical industry

SH/T 3153 Petrochemical telecommunications design code

TSG 21 Supervision regulation on safety technology for stationary pressure vessel

TSG D0001 Pressure pipe safety technology supervision regulation for industrial pressure pipe

3 Terms and definitions

The following terms and definitions apply to this document.

3.1

Key access path

Expressways, first-class highways, second-class highways, railway and waterway trunk lines, urban expressways, and other transportation routes.

3.2

Safety distance

The minimum permissible distance -- BETWEEN the boundary of the phosgene and phosgenation product production unit (the outermost axis of the unit) AND the relative concentration areas.

3.3

Phosgenation products

Products produced by the chemical reaction of phosgene with one or more chemical substances.

3.4

The relative concentration areas

Areas where people gather, such as public facilities including residential areas, schools, hospitals, nursing homes, cultural venues, commercial venues, passenger ports, passenger terminals, passenger stations, passenger airports, parks, stadiums, amusement parks, as well as labor-intensive workplaces (workshops or factories with more than 100 workers at any one time), employee dormitories (including shift dormitories).

3.5

Phosgene badge

A test paper that indicates a person's exposure to phosgene (the product of exposure concentration and time), by which it can read the exposure dosage using a colorimetric chart.

Note: Phosgene badges are also called phosgene cards or phosgene signboards.

3.6

Fluid containing phosgene

A gaseous medium containing at least 0.2% phosgene by volume, or a liquid medium containing at least 1% phosgene by mass.

4 Planning and layout

4.1 Basic requirements

4.1.1 Safety facilities for newly built, expanded, renovated projects shall be designed, constructed, put into production, used simultaneously with the main project.

4.1.2 Phosgene and phosgenation plants shall be designed by an organization with Class A comprehensive engineering design qualification or Class A professional qualification in the chemical, petrochemical, pharmaceutical industries.

4.1.3 A Hazard and Operability Analysis (HAZOP) shall be conducted during the basic design phase for phosgene and phosgenation plants.

4.1.4 Safety assessments (pre-assessment, acceptance assessment, current safety assessment) shall be conducted at different implementation stages for phosgene and phosgenation plants. These safety assessments shall comply with the provisions of AQ 8001; their procedures and content shall adhere to relevant requirements.

4.1.5 Fire protection measures for phosgene and phosgenation product production plants shall comply with the provisions of GB 55037 and GB 50016. Depending on the type of enterprise, they shall also comply with the relevant provisions of GB 50160 and GB 51283.

4.1.6 Exposure limits for toxic and hazardous substances in the workplace during phosgene and phosgenation product production shall comply with the provisions of GBZ 2.1. The overall layout, plant design, auxiliary room configuration shall comply with the requirements of GBZ 1.

4.1.7 Phosgene and methyl isocyanate shall be used immediately upon production and shall not be transported to other locations (including other production plants within the industrial park) or transported via pipelines (including inter-plant pipelines).

4.2 Site layout

4.2.1 Phosgene and phosgenation product production projects shall be located within a chemical park.

4.2.2 The project site layout shall comprehensively consider the total safe amount of phosgene within the chemical park and the bearing capacity of the surrounding environment.

4.2.3 Phosgene and phosgenation product production projects shall undergo risk assessment and demonstration and, while complying with safety requirements, adhere to the principles of industrial agglomeration, centralized layout, intensive land use.

4.3 Site selection

4.3.1 The site selection for phosgene and phosgenation production projects shall comply with the requirements of the national industrial layout and local master plan.

4.3.2 Newly built, expanded, renovated projects must meet the following requirements:

a) They shall not be located in areas with a seismic fortification intensity of 8 degrees or higher (inclusive);

b) They shall be located upwind of densely populated residential areas and towns with the lowest annual wind frequency;

5 Design

5.1 Process

5.1.1 The water content of carbon monoxide and chlorine gas entering the phosgene synthesis process shall not exceed 50 mg/m^3.

5.1.2 Phosgene synthesis and phosgenation equipment and piping systems must be kept dry; no moisture is permitted.

5.1.3 The following measures shall be implemented for cooling the phosgene and phosgenation product production system:

a) Non-aqueous liquids that do not create secondary hazards upon contact with the system media shall be used as coolants. If non-aqueous liquids do not meet process requirements and water or aqueous solutions are necessary as coolants, reliable protective measures shall be implemented to prevent water or aqueous solutions from entering the process material side. In addition, process materials shall be prevented from entering the coolant. An online pH (or conductivity) analyzer with an alarm function shall be installed on the coolant side.

b) When water or aqueous solutions are used as coolants for storage tanks, cooling coils shall not be installed within the tank.

c) When water or aqueous solutions are used as coolants for heat exchangers, shell-and-tube heat exchangers shall utilize double tubesheets.

5.2 Equipment

5.2.1 The design, manufacture, installation, use, inspection and acceptance, repair, modification of pressure vessels shall comply with TSG 21.

5.2.2 Fluid containing phosgene shall be transported by gravity or by leak-proof pumps (such as canned or magnetic drive pumps). If the process requires a mechanical seal pump, a double-end mechanical seal pump with seal flushing shall be used.

5.2.3 The sealing fluid used in pumps containing phosgene shall be compatible with the process conditions; water or aqueous solutions shall not be used. The sealing fluid pressure shall be higher than the process pressure. There shall also be a leak monitoring system for the sealing fluid. Local negative pressure suction and exhaust ventilation shall be installed near the pump, with the exhaust connected to the phosgene destruction system.

5.2.4 The corrosion margin for equipment containing phosgene shall be determined based on production conditions and material quality. The corrosion margin for carbon steel or low-alloy steel shall not be less than 3 mm. Materials used in phosgenation equipment shall be abrasion-resistant. 100% non-destructive testing shall be performed on butt welds.

5.2.5 Sight glasses should not be used in equipment containing phosgene. If the process requires them, sight glasses with protective covers shall be used; meanwhile local negative pressure suction and exhaust ventilation shall be installed near the sight glasses, with the exhaust connected to the phosgene destruction system.

5.2.6 Pressure vessels containing phosgene media shall be designed to be intrinsically safe or adopt active safety measures to avoid overpressure. Safety relief devices shall be installed according to the unit system. The safety relief devices shall discharge to the emergency destruction treatment system in a closed manner and shall not be discharged directly into the atmosphere.

5.2.7 The number of equipment and the storage capacity of each storage tank for highly toxic materials such as liquid phosgene, methyl isocyanate, methyl chloroformate (their primary hazardous characteristics are described in Appendix A) shall be minimized and meet the following requirements:

a) The total storage capacity of the storage tanks shall be controlled; the volume of a single storage tank shall not exceed 5 m^3;

b) The filling factor of a single storage tank shall be controlled below 75%;

c) An emergency collection tank of appropriate system capacity shall be provided;

d) The discharge pipe of the storage tank should not be connected to the side or bottom;

e) The storage tank shall be equipped with a safety valve with a bursting disc

installed upstream of the safety valve. The safety valve outlet shall be connected to the emergency rupture control system; an overpressure alarm shall be installed between the bursting disc and the safety valve;

f) The material of the liquid phosgene storage tank shall be low-temperature resistant; methyl isocyanate storage tanks shall not use equipment, instruments, or components made of ordinary carbon steel or alloys containing copper, zinc, or tin.

5.2.8 Heat exchangers and shell-and-tube phosgene synthesis reactors containing phosgene must meet the following requirements:

a) Tube bundle vibration must be prevented during design;

b) Heat exchange tubes must be seamless steel tubes;

c) Expansion joints must not be used on the phosgene side of the heat exchanger;

d) Fin-tube heat exchangers and air coolers must not be used.

5.3 Pipelines

5.3.1 The design, manufacture, installation, use, inspection, testing, acceptance, repair, modification of metal pipelines containing phosgene shall comply with the requirements of TSG D0001 and GB/T 20801 (all parts).

5.3.2 Pipelines containing phosgene shall not be made of brittle materials; seamless metal pipes are preferred. Pipeline branch connections shall use integrally reinforced branch connection fittings or tees.

5.3.3 Phosgene-containing units within phosgene and phosgenation production plants shall be isolated in sections. Emergency shut-off valves shall be installed to isolate and partition the units, dividing the large unit into multiple sections. The gas phase of each section shall be connected to the phosgene destruction system; the liquid phase shall be connected to the emergency collection tank.

5.3.4 The installation and laying of pipelines transporting fluid containing phosgene must comply with the following requirements:

a) Support and fixings must minimize stress, vibration, friction.

b) Pipelines passing through solid walls or floors must be installed within protective casings.

c) Pipelines must not pass through living rooms, offices, transformer rooms, evacuation stairwells, or unrelated process equipment, system units, or storage tanks. They must not be directly buried or laid in trenches.

d) Gaseous phosgene pipelines must have measures to prevent phosgene liquefaction and avoid gas-liquid two-phase flow in the pipelines, which could cause pipeline vibration and erosion.

e) Pipelines transporting fluid containing phosgene shall not be installed adjacent to pipelines carrying hot fluids or corrosive materials, nor shall they be installed beneath pipelines carrying corrosive liquids.

5.3.5 Pipelines transporting fluid containing phosgene must be butt-welded, not threaded. The weld joint inspection level must comply with Level I requirements in GB/T 20801.

5.3.6 Pipelines containing phosgene shall not be jacketed with steam, hot water, or water.

5.3.7 Pipeline insulation shall be implemented to prevent moisture penetration (especially from ocean air) that could cause corrosion.

5.3.8 Utility pipelines connected to pipelines containing phosgene shall be equipped with backflow prevention measures. Utility pipelines used only during equipment shutdown shall also be equipped with blind plates.

5.3.9 Pipeline accessories prone to leakage (such as metal bellows, sleeve compensators, spherical compensators) shall not be installed on pipelines containing phosgene.

5.3.10 Sight glasses should not be used on pipelines containing phosgene. If sight glasses are required for the process, they shall be protected with protective covers and shut-off valves installed before and after the sight glasses. Local negative pressure exhaust ventilation shall be installed near the sight glasses, with the exhaust connected to the phosgene destruction system.

5.3.11 Sampling valves, mechanical seals, flanges, and other areas where phosgene may leak shall be protected by local negative pressure exhaust systems, with the exhaust connected to the phosgene destruction system.

5.3.12 Vent and drain valves in pipelines containing phosgene shall be installed in accordance with the following requirements:

a) Exhaust materials shall be collected and treated in a centralized, sealed manner, with the exhaust connected to the phosgene destruction system and the liquid connected to an emergency collection tank;

b) Vent and drain valves shall utilize double shut-off valves;

c) Vent and drain valve outlets shall be equipped with local negative pressure suction and exhaust facilities, with the exhaust connected to the phosgene destruction system.

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