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Indian Standard

CODE OF PRACTICE FOR VENTILATION IN PETROCHEMICAL PLANTS AND REFINERIES

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Indian Standard

CODE OF PRACTICE FOR VENTILATION IN PETROCHEMICAL PLANTS AND REFINERIES

0. FOREWORD

0.1 This Indian Standard was adopted by the Bureau of Indian Standards on 30 March 1988, after the draft finalized by the Functional Requirements in Buildings Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Provisions for ventilation in petroleum refineries is important not only from comfort viewpoint but also to enable environmental protection, material control and reuse. An attempt has been made in this standard to briefly describe measures to reduce heat due to processes in petroleum refineries. For ventilation in general industries, reference shall be made to IS : 3103-1975*.

0.3 Attention is invited to IS : 10179-1982* which is also related to petroleum refineries.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Code of practice for industrial ventilation (*first revision*).

*Code of practice for control of air pollution in petroleum refineries.

†Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard covers certain basic requirements regarding safe design, installation, operation and testing of ventilating systems with respect to industrial ventilation related to petrochemical plants and refineries.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Air Change per Hour — The volume of outside air allowed into a room in one hour compared with the volume of the room.

2.2 Axial Flow Fan — A fan having a casing in which the air enters and leaves the impeller in a direction substantially parallel to its axis.

2.3 Capture Velocity — Air velocity at any point in front of the exhaust hood necessary to overcome opposing air currents and to capture the contaminated air at the point by causing it to flow into the exhaust hood.

2.4 Centrifugal Fan — A fan in which the air leaves the impeller in a direction substantially at right angles to its axis.

2.5 Contaminants — Dust, fumes, gases, mists, vapours and such other substances present in air which are likely to be injurious or offensive to the occupants.

2.6 Dilution Ventilation — Supply of outside air to reduce the air-borne concentration of contaminants in the building.

2.7 Dry Bulb Temperature — The temperature of air read on a thermometer placed in such a way as to avoid errors due to radiation.

2.8 Exhaust of Air — Removal of air from a building and its disposal outside by means of mechanical device, such as a fan.

2.9 General Ventilation — General ventilation consists of the removal of air from, or the supply of air to a general area in an enclosed space.

2.10 Humidification — The process whereby the absolute humidity of air in a building is maintained at a higher level than that of outside air or at a level higher than that which would prevail naturally.

2.11 Humidity, Absolute — The weight of water vapour per unit volume.

2.12 Humidity, Relative — The ratio of actual to partial pressure of water vapour at the same temperature.

2.13 Local Exhaust Ventilation — Ventilation affected by exhaust of air through an exhaust appliance, such as hood, with or without fan, located as closely as possible to the point at which contaminants are released so as to capture effectively the contaminants and convey them through ducts to a safe point of discharge.

2.14 Make-Up Air — Outside air supplied into a building to replace the air removed.

2.15 Mechanical Ventilation — Supply of outside air either by positive ventilation or by infiltration by reduction of pressure inside due to exhaust of air, or by a combination of positive ventilation and exhaust of air.

2.16 Natural Ventilation — Supply of outside air into a building through window or other openings due to wind outside and convection effects arising from temperature or vapur pressure differences (or both) between inside and outside of the building.

2.17 Positive Ventilation — The supply of outside air by means of a mechanical device, such as a fan.

2.18 Propeller Type Fan — A fan in which the air leaves the impeller in a direction substantially parallel to its axis, designed to operate normally under free inlet and outlet conditions.

2.19 Spray-Head Systems — A system of atomizing water so as to introduce the moisture directly into a building.

2.20 Temperature Rise — Difference of exit temperature and the temperature of air at the inlet openings.

2.21 Threshold Limit Values (TLV) — Refers to air-borne concentration of contaminant and represents conditions under which it is believed that nearly all occupants may be repeatedly exposed, day after day, without adverse effect.

2.22 Ventilations — Supply of outside air into, or removal of inside air from an enclosed space.

2.23 Wet Bulb Temperature — The steady temperature finally given by a thermometer having its bulb covered with gauze or muslin moistened with distilled water and placed in an air stream of not less than 4·5 m/s.

3. CRITERIAN FOR LOCATION OF BUILDINGS

3.1 Solar Load — The building shall preferably be located in such a way as to minimize the solar gain, for example, the wall having maximum glass area shall not be facing West

3.2 Area Classification — The building shall be located preferably in an electrically safe (non-hazardous) area which would eliminate use of equipment suitable for hazardous area and thus minimize cost and risk. The building shall not be located in populated areas. It should not adversely affect the environment and the surroundings. The location shall take into account the Environment Act, 1986.

3.3 Wind Conditions — Cracks, crevices, window openings, if inevitable, shall be so located as to minimize infiltration into the building.

4. DESIGN CONSIDERATIONS

4.1 Need for Ventilation

4.1.1 *Comfort* — Heat, odours and fumes can be removed from working areas by exhaust ventilation using conditioned, ambient air depending upon the requirement.

4.1.2 *Material Control and Reuse* — Local exhaust ventilation may be used to conserve reusable material when reusable resource released from process can be collected by a ventilation system and then removed from air stream for recycling by using an air-cleaner at a lower cost than replacing the material.

4.1.3 *Environmental Protection* — Ventilation systems are used to control the contaminants produced by industrial process, and air cleaners remove the contaminant before the air is discharged to the environment. The basic purpose is to remove contaminants so that the residual in the discharged air meets the air pollution limits. To meet these requirements, a local exhaust system may be considered.

4.2 Basis of Design

4.2.1 *Control Room* — System should be capable of removing heat generated from control panels and to provide comfort to the operating personnel. Dry bulb temperature should be maintained around 27 ± 2°C and relative humidity not exceeding 65 percent. Fresh air shall be taken at the rate of 1½ airchanges per hour. This shall be achieved, if necessary, by using vapour compression refrigeration systems. It is a good practice to provide air filtration down to 5 micron dust particle size.

4.2.2 *Sub-Stations/Elevators Machine Room* — System should be capable of removing heat generated from HT/LT panels, so as to maintain the inside dry bulb temperature not exceeding 3 to 5°C above amient conditions. From the ventilation consideration, a minimum of 12 air changes per hour shall be considered. However, the greater of the two shall govern. In such areas which are normally unattended, human comfort is of secondary importance. Where the areas under consideration are located in classified zones (hazardous areas), or where dust pollution is to be prevented, pressurization inside shall be resorted to. Fresh supply air should be free from organic matter and deleterious inorganic dust fume, and should be drawn from areas where the air is not likely to be polluted. The recommended positive pressure values above atmospheric are 5 mm to 10 mm WC (50 to 100 Pa). In case of critical application where close monitoring of positive pressure is required, differential pressure sensors/actuators will be used along with relief dampers.

In case elevator machine room is located in classified zone, it is good practice to cutoff power supply to elevators in case of drop in pressure with a time delay switch to enable the elevator to reach the nearest landing.

4.2.3 *Cable Tunnels* — As a recent practice, the cables for various petrochemical/refinery plants are laid inside the tunnels below ground level and the length of these tunnels may vary from 2 to 4 km. Since these tunnels may be accessible to operators for maintenance, etc, adequate ventilation shall be provided for supply and exhaust systems comprising propeller or centrifugal fans located at suitable distance all along the tunnel. The general criteria for sizing of fans would also be 12 air changes per hour unless heat generated inside calls for more air changes. In either case, the temperature in the tunnel should not exceed by 5°C above ambient.

4.2.4 *Workshops Maintenance Shops/Battery Storage-cum-Charging* — These are normally large housings comprising light duty machine tools, welding, cutting and brazing stations, grinding, polishing and buffing stations, and battery storage-cum-charging stations. The intent is to keep workers exposure against heat/fumes/dust below the permissible levels by ventilation. The general ventilation requirement shall be met by exhausting ambient air at the rate of 12 air changes per hour. In addition, localized ventilation with necessary hoods/ducting shall be provided to prevent spreading and mixing up of hazardous/toxic fumes/contaminants.

For welding areas, local exhaust is recommended which may comprise of a movable hood or fixed enclosure. The movable hood must develop air velocity of at least 30·5 m/min in the welding zone. Fixed enclosure must develop an air velocity of at least 35·5 m/min away from the welder.

Most important consideration here is to achieve the velocity specified above, in the welding zone which effectively reduces air borne contaminants level.

Any effective means of local ventilation is acceptable for grinding, polishing and buffing stations. All exhaust ventilation systems must be equipped with suitable dust collector.

A forced supply and positive exhaust system is recommended in battery storage and charging areas, in order to dilute the hydrogen evolved during battery charging process; however, the type of fans and other electrical fittings used here shall be of explosion proof construction (*see* IS : 2148-1981*). Generally it is required to provide adequate vents to permit safe release of leaking hydrogen. Air inlets to the room shall be located near the floor in exterior walls only. Outlet opening shall be located at the high point of exterior walls or roof.

4.2.5 *Diesel Generator Room* — The engine exhaust must always be taken outside the room to a safe area. If the radiator is mounted inside the room, the air changes per hour shall be adequate to not only remove the heat from cooling water but also the radiant heat from both the alternator and the engine. If necessary, additional exhaust fans may be provided in the walls to supplement the radiator system. For inlet air to the generator room, necessary louered openings with bird screen shall be provided to take care of both the exhaust requirement and the combustion air requirement; alternatively, inlet fans may also be provided if layout or space permits.

The basic criteria for heat removal shall be to arrive at an air change per hour with permissible temperature rise of 3 to 5°C above ambient temperature.

4.2.6 *Localized Fumes, Hot Air, Toxic Gases, etc, in Process Areas* — For control of localized fumes, etc, it is recommended to provide local exhaust systems in order to capture or contain contaminants/fumes, etc, at their source before they escape into the workroom space. A typical system shall consist of hoods, ducts, air cleaner, if needed, and a fan.

Attention shall be paid to provide properly shaped hood and its location.

4.2.7 *Pit Ventilation* — When the equipment is installed in underground pits, ventilation is necessary for the following two reasons:

a) To remove heat generated by equipment, and

b) To remove obnoxious/toxic gases and contaminants from the pit to make the space conducive for working.

4.2.7.1 *Systems*

a) For heat removal, forced supply or forced supply coupled with positive

*Specification for flameproof enclosures of electrical apparatus.

exhaust ventilation system may be used. Air flow rate shall be sufficient to bring down pit temperature as not to exceed 5°C over outside ambient temperature. However, it shall be ensured that air is supplied at a minimum of twelve (12) air changes/hour.

b) For removal of gases/contaminants, mechanical exhaust ventilation system shall be provided. Necessary ducting with exhaust grill, blowers, chimney, etc, shall form a part of the system. Air exhaust rate shall be in range of 12 to 20 air changes/hour depending on the exact application.

4.2.8 *Process Applications* — Areas which require high relative humidity of desired dry bulb temperature and large air volumes, need to be served with air washers. While maintaining the required dry bulb temperature or humidity, the air washer serves to act as a filter also for dust, etc, and other gaseous fumes which should not be allowed to enter the conditioned space.

Such systems are useful where the sensible heat generation from machinery and other manufacturing processes within the conditioned space is very high.

5. SYSTEM COMPONENTS

5.1 Fan

5.1.1 Fan selection shall match the requirements of ventilation system. Depending upon application, the following types of fans may be used:

a) *Centrifugal* — Backward curved blades with non-overloading characteristics, or forward curved, or radial blade;

b) *Tube Axial*; and

c) *Propeller*.

5.1.2 If the system resistance cannot be evaluated firmly, it is advised to go in for non-overloading type of fans depending upon suitability of the application.

5.2 Hood — Hood is the most important part of the ventilation system since it has to capture contaminants to make the atmosphere conducive for work. Depending upon the requirement, the following types of hoods may be provided:

a) *Enclosure* — There are hoods that surround the contaminant sources as much as possible. The quantity of air required is calculated by multiplying the inward air velocity, needed to prevent escape, by the area of doorways and other openings in the enclosure.

b) *Receiving* — This type of hood is so positioned as to catch the contaminants thrown at it. The air flow requirements are based on volume of the contaminated air coming at it.

c) *Capturing* — These types reach out to capture contaminants in the work room air. Air flow into the hood is calculated to generate sufficient capture velocity in the air space in front of the hood.

5.3 Duct — Duct has third priority in importance in the overall ventilation system. Duct diameter and the number and type of bends and elbows affect the resistance of the duct network. The entire ducting shall be designed to distribute the air flowing into each hood to meet design air flow criterion in all hoods. The aim is to design the system with every component working properly and efficiently. Duct work should be such that air flows straight into the fan inlet without any turbulence. Use of elbows or boxes should be avoided prior to fan inlet. It is recommended to provide for supply air fan, an outlet duct ranging in length from 2½ to 6 fan wheel diameters, depending upon velocity, to allow the fan to develop its full rated pressure.

5.4 Air Cleaner

5.4.1 Ventilation system requires an air cleaning device to remove the contaminants collected in the system before the air is discharged into the environment. Air cleaners are selected for their efficiency of removing the contaminants in the air.

5.4.2 *Removing Particulates* — Particulates (dust/smoke/fumes mist) can be removed from the exhaust gas using centrifugal collectors, filters, electrostatic precipitators or baffle plates.

5.4.3 *Fabric Filters* — Fabric filters may be used for applications involving fine separation of high toxic particulates/fumes ensuring that the fluid handled does not have suspended moisture.

5.4.4 *Absolute Filters* — These are most efficient air cleaner and are at least 99·9 percent efficient in collecting a 0·3 micron aerosol. The use of prefilter or another type of air cleaner preceding the absolute filter is essential.

5.4.5 *Removing Gases and Vapours* — These are usually removed from exhaust air using activated carbon absorption, liquid scrubbers or incineration.

5.5 Instrumentation and Controls

5.5.1 Operating interlocks and contaminant or air flow sensors to monitor system performance are required. Interlocks may be needed between the ventilation system and the process machinery so that machinery will operate only when the air flow is adequate. The simplest interlock is to operate both the ventilating fan and the machinery with the same switch.

5.5.2 Pressure activated switches used as interlock will permit thc machine to operate only when there is sufficient differential pressure in the area under consideration.

5.5.3 When air cleaning devices are used, differential pressure indicators must be installed across them so as to warn the operator of necessary cleaning/back washing operation.

5.5.4 Fire/smoke dampers along with detectors shall be provided and shall be interlocked with the fan drive and supply/return dampers.

5.5.5 Temperature indication shall be provided in the work room where temperatures are required to be maintained within specified limits.

6. INSTALLATION AND OPERATION

6.1 Location — Fans, drivers, and filters shall be located in a convenient position in or adjacent to building to be conditioned, care shall also be taken to ensure accessibility to fresh air, maintenance/operation equipment and noise control.

If plants are located in hazardous area, fresh air shall be taken from safe area. The fan shall be in non-sparking construction while motor shall be in flameproof construction (*see* IS : 2148-1981*).

6.2 Adequate access for inspection, reasonable space during operation, location of dampers and other controls in such a position as to permit quick and easy operation and adequate lighting and ventilation of plant room are some of the important considerations while deciding the plant room layout.

7. TESTING

7.1 Test at Works

7.1.1 *Fans* — The fans shall conform to IS : 2312-1967* and IS : 4894-1968†.

7.1.2 *Filters* — Filters shall be tested as per IS : 7613-1975‡.

7.2 Test at Site — The entire ventilation system shall be performance tested at site to meet the design conditions.

7.3 The suggested duct velocities for various media shall be as follows:

Conveying Medium	*Design Velocity* (m/sec)
Vapours, gases and fumes	10 to 12
Fine dry dust	15 to 16
Average industrial dust	17·5
Coarse particles	17·5 to 22·5
Large particles, heavy load moist material	22·5 and over

*Specification for flameproof enclosures of electrical apparatus.

*Specification for propeller type ac ventilating fans (*first revision*).

†Specification for centrifugal fans.

‡Method of testing panel type air filters for air-conditioning and ventilation purposes.

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