

**VENTILATION, AIR-CONDITIONING AND HEATING – DESIGN STANDARD****1. GENERAL PROVISIONS**

- 1.1 This Standard is applied for design of ventilation, air-conditioning and heating for newly-built or renovative constructions.
- 1.2 This Standards is not applied for:
  - a. Types of:
    - Testing house or works or special construction;
    - Specialized house or works (underground tunnel, with explosive or radio-active isotopes, etc.);
    - Works of underground mine exploitation;
    - Short-term residential and industrial buildings (or in seasons);
  - b. Design of ventilation system to protect against smoke for residential and industrial buildings in cases of fire;
  - c. Design of air-conditioning, cooling, heating systems used in technological and electric equipments (Vacuum cleaning system), house cleaning and equipments, dry system, cooling system, dust disposal for materials and finished production, delivery system of finished production and industrial waste, wind blowing system for engine-cooling and electric equipments, etc...);
  - d. Design of protecting shade for technological equipments or work stage (at areas of originating toxic gas in production), connection point to local wind loading sytem.
- 1.3 This Standard shall provide the technical solutions in order to ensure the hygiene standards, fire protection and safety techniques which must be followed in design of ventilation, air-conditioning and heating for houses and buildings.
- 1.4 When design of ventilation, air-conditioning and heating, the technological, architectural and structural solutions must be suitably combined in order to ensure the hygienic requirements, technical regulations and economic saving.
- 1.5 Equipments, pipe, wind conduit placed in production rooms with erosion environment, as well as air carrying equipments with gas, dust, erosion steam must be made from anti-erosion or with cover layer to protect against erosion.

For expansion container, or other types of water tank need to have protection layer against erosion both inside and outside.
- 1.6 The engines used for ventilation, air-conditioning and heating must be selected in accordance with requirements of power supply for factory, residential and industrial buildings or clearly specified in this design.
- 1.7 For residential and industrial buildings under group A, B, C and F and public buildings, it is necessary to facilitate the cutting from control panel, control cabinet or from press button of ventilation, air-conditioning, heating system in rooms of fire, except the air supply to transfer rooms of production compartment under group A, B and F shall be uninterrupted air supply system in case of fire.

For residential and industrial buildings under group C, it is acceptable to cut only the serving systems for separate lines or areas with area of not smaller than 2,500m<sup>2</sup>.

For residential and industrial buildings and compartments with automatic fire alarm and fire protection system, these systems must be connected with ventilation, air-conditioning, heating systems to automatically cut these systems during the operation of fire alarm and fire protection system.

- 1.8 In design of ventilation, air-conditioning and heating system, the earthing requirements must be clearly defined for the whole ventilation, air-conditioning and heating equipments, metal air piping, metal pipes serving production compartments and production rooms under group A, B and F as well as air pipes, pipes and systems for discharging explosive substances from local air exhaust mechanism.
  - a. By connecting this system on its whole length to an uninterrupted circuit;
  - b. By connecting each system with at least 2 points to earthing system of lightning equipments and system according to current Standard.
- 1.9 For heating surface of pipes, air piping, ventilation, air-conditioning and heating equipments, located at production rooms (including technical floors), where these heating surfaces may cause fire and/or explosion, they must be provided with insulated cover to reduce the temperature of surface of insulated layer to safety level regardless of demand for surplus heat usage from these surfaces.
- 1.10 Equipments (fan, dust filter film, lock valve, etc...) air piping, deafener, insulated materials, filling materials made from products with high possibility of originating toxic gas grade 1 and grade 2 in case of fire as well as during its operation.

*Note: If toxic features of materials are not available, before used in design, the testing on these areas are necessary.*
- 1.11 Deafener of ventilation and air-conditioning systems must be made from incombustible materials.
- 1.12 The solutions on space-plan of residential and industrial buildings under group A, B and F where possibility of forming explosive and flammable substances (steam, air and dust) may be occurred, as well as residential and industrial buildings with toxic source and surplus heat releasing more than 20 kcal/m<sup>3</sup>.h must be constructed in a way that no formation of unaired area and "bag" is produced in the buildings.
- 1.13 Windows and skylights must be arranged and calculated to expel the transmission of toxic gas from this rooms to others. These entrance, if located within people reach, a manual open/close mechanism must be provided beside other mechanical ones.
- 1.14 When design of air piping together with other structures made from construction materials (masonry brick, etc.), the measures on tightness reliability of pipes and measures on reduction of inside surface roughness and sanitation condition must also be planned when necessary.
- 1.15 In design, construction and installation and technology, fixed and movable lifting facilities (pulley, winch, crane – in case of big equipments) must be provided at rooms with ventilation, air-conditioning and heating equipments for repair and technical appraisal of dynamic mechanism of equipments (fan, engine, etc...) if the weight of 1 equipment unit exceeds 50 kg.

*Note: No need of transport-lifting equipments is foreseen if transport-lifting appliance in technology line of the factory and production room can be used to serve the ventilation, air-conditioning and heating systems.*

- 1.16 The selection of ventilation, air-conditioning and heating systems, selection of equipments, structure and materials for these systems must be implemented on basis of local material sources and production, to avoid the distant delivery of materials.
- 1.17 In design of ventilation, air-conditioning and heating systems for residential buildings, factory and buildings with demand for manpower provision for operation and repair in accordance with guidances, regulations on these fields and current regulations.
- 1.18 In design of ventilation, air-conditioning and heating systems for residential and industrial buildings which placed on settleable and sliding soil, the protection measures against wet subgrade under the building must be outlined by draining water in underground ditch, underground pit as well as other water collection points.
2. **Microclimatic condition and cleanness of inside atmospheric environment and inside calculated climatic parameters.**
  - 2.1 For residential and public buildings (administration, classroom, etc...), subsidiary house in industrial enterprises or industrial buildings with inside technology line without special requirements on parameters of atmospheric environment, then mainly the solutions on architecture and construction physics shall be used to design the shielded enclosure in order to keep heat and avoid cold wind in winter; to ensure the aeration by natural ventilation, cross wind in summer, combined with table fan and ceiling fan, etc..in accordance with TCVN 4605: 1988 on "Technical heat, shielded enclosure – Design standard" in order to ensure the comfort of inside environment.
  - 2.2 In case the technical methods on ventilation, air-conditioning and heating are used to ensure the environmental comfort, the parameters on comfortable microclimate shall be referred to Appendix I.  
For residential building, comfortable microclimate limit shall be referred to Appendix 2.
  - 2.3 In case ventilation and natural ventilation can not ensure the comfortable microclimate, in order to balance the increase of environmental temperature, air movement speed must be increased to maintain the heat feeling figure in allowable limit. For every 1°C temperature increase, the wind velocity must increase 0.5 - 1m/s, but not exceeding 3 - 4m/s for residential building and 5 - 6m/s for industrial building.  
  
Above limit for endurance possibility may accept  $t = 37,5^{\circ}\text{C}$  with moisture of  $\phi = 80\%$  in static condition.
  - 2.4 Comfortable microclimate in Appendix 1 are set for people with normal clothes domestic staying period of over 2 hours.  
  
If the domestic staying period is shorter, temperature index in this Appendix can be increased (equivalent to hot season) to 0.4°C for each amplitude exceeding 30°C of outside calculated atmospheric temperature (but not exceeding comfortable limit for natural microclimate according to Appendix 2).
  - 2.5 The Microclimatic condition (temperature, average moisture, wind velocity) in breeding facilities and agricultural buildings, as well as in agricultural maintenance houses (seed store, cold storage, etc..), approved dedicated technology standards shall be taken into account.

- 2.6 Microclimatic condition at regular working places of the production room with radiation intensity of more than 300 kcal/m<sup>2</sup>.h, it can only be partly ensured by guided methods stated in article 3.1.7
- 2.7 Allowable limit concentration of toxic gas (gas, air, dust, etc.) in working environment of production space belonging to enterprises or other buildings shall be limited in Appendix 4.

Outside working hours, standard microclimatic condition may not be maintained if this does not violate other approved standards.

- 2.8 When calculation of air distribution through ventilation, air-conditioning and heating systems, extreme value (maximum or minimum) of wind velocity  $W_x$ , temperature  $t_x$ , and atmospheric moisture  $\phi_x$  must be ensured to be within the allowable limit of hygienic standards at imported wind section to working or serving areas; for air swirling flow, working people's chest shall be taken into consideration.

Notes:

1. Toxic gas concentration in air supply to building, determined air supply intake shall not exceed 30% of allowable limit concentration.
2. Direct impact area of flow shall be regulated to be flow area with wind velocity from maximum  $W_x$  to  $0.5W_x$ .
3. When air distribution opening is placed in working area, the average temperature and moisture and velocity outside working area may not need to follow the standard in following cases:
  - a. at distance of 1m from air supply opening if supply flow is horizontal or inclined.
  - b. at distance of 0.5m from air supply opening if supply flow blows vertically upwards.

- 2.9 When calculation of air distribution to ensure the microclimate at working place and area with regular impact of outside-scope people on blowing flow, the speed of  $0.5W_x$  shall be taken as a criterion, while temperature and moisture shall be arithmetical average of these quantities at imported flow to working area.

Note: When design of these systems, the guidelines of article 2.8 must be taken into account.

- 2.10 Working and serving areas in residential, public and supporting buildings of 2m height from floor and mainly with seating people in these space (theatre, working room, lecture hall, etc.) can be taken as 1.5m from floor.

Working area in industrial buildings can be taken according to industrial design standards and technology requirements.

- 2.11 Outdoor calculated climatic parameters shall be taken according to TCVN 4088: 1985 and treated under grade I, II, III applied for special grade of the building (Appendix 3).

Calculated parameters under grade I used to design the buildings with special importance when allowable time can not ensure the calculated heat and moisture regimes, must be small (under 50h/year).

Calculated parameters under grade II used to design almost residential and industrial buildings when allowable time can not ensure the calculated heat and moisture regimes, must be within the area of 200 - 300h/year. These parameters can be used to calculate ventilation, air-conditioning and heating system under grade II (in winter).

Calculated parameters under grade III used to design the buildings when time period can not ensure the heat regime, shall be reach to 400 - 500 h/year.

### 3. Ventilation, air-conditioning and heating

#### 3.1 General instructions

3.1.1. Ventilation and air-conditioning systems must be designed in a way to ensure the cleanness of atmospheric environment and inside microclimatic condition of the buildings in accordance with standards in terms of sanitation, technology and comfort.

3.1.2. Natural ventilation (including cyclic room aeration) must be organized, if not having influence on technology process, heat feeling of people or protection of materials and equipments in the building.

3.1.3. Mechanical ventilation must be designed if microclimatic conditions and hygienic requirements can not be ensured by natural ventilation.

In rooms with presence of people, if without air-conditioning system, ceiling or table fans must be provided as support for natural ventilation if not having influence on requirements in terms of technology and sanitation.

*Note: Number of fans are read in rooms must be adequate to ensure the wind velocity according to heat feeling. In case of unavailability of calculated data, 1 fan can be selected for every 16-25m<sup>2</sup> of floor area. The fan must be with velocity changing regime to meet the using demand.*

*Distance from air vane to floor surface shall not smaller than 2.3m.*

3.1.4. Mechanical and natural mixing ventilation must be designed if possible and one part of natural ventilation can be used for air supply and exhaust.

3.1.5. Air-conditioning must be designed to:

- a. Ensure the sanitation and microclimatic conditions in accordance to the Standard, when these conditions can not ensured either by mechanical or natural ventilation, or vapour cooling (adiabatic process);
- b. Ensure and maintain the microclimatic condition and air fresh in the building or a part of the building according to technology requirements;
- c. Ensure and maintain the comfortable microclimatic conditions or intermediate conditions between comfortable or allowable conditions in production room as stated in Appendix I, 2, if these articles are economically suitable.
- d. Ensure and maintain the microclimatic condition and air fresh as regulated for residential and public buildings or subsidiary house when necessary.

Notes:

1. If Standards and Codes on technology do not fix the microclimatic parameters, it must be ensured that when design of air-conditioning system, the optimum microclimatic parameters shall be taken.
2. The accuracy for preservation of comfortable microclimatic condition, if without special requirements, should be kept at  $\pm 10^\circ\text{C}$  according to temperature and  $\pm 7\%$  according to moisture (around place of temperature and moisture sensor).

*The accuracy for preservation of comfortable temperature during operation of local air-conditioning or local mixer with sensor head having direct impact, can be kept at  $\pm 2^\circ\text{C}$ .*

3.1.6. When radiation source on people reach intensity from 150 to 300 kcal/m<sup>2</sup>.h and radiation area during its operation exceeding 0.2m<sup>2</sup> air temperature according to Appendix 1 and 2 can not be ensured, air velocity can be increased according to requirement of article 2.3.

To ensure above-mentioned microclimatic conditions, local blowing fan shall be provided.

3.1.7. Air-bathing supply system to regular working place must be provided:

- a. When radiation intensity exceeds 300 kcal/m<sup>2</sup>.h: outdoor air supply to ensure the environmental parameters (temperature and wind velocity) according to "Hygienic standards for design of industrial buildings".
- b. For trial production process causing pervasion of toxic gas without possibility to design safety hood and local inspiration: outdoor air supply to ensure the environmental parameters (temperature, wind velocity, toxic concentration) according to Appendix I, 2 and 4 of this standards.

*Note: When design of air-bathing systems, protection measures against sliding blowing of toxic gas to nearby working rooms must also be planned.*

- 3.1.8. Air-ventilation only needs to be combined with air-conditioning or technological demands, if any. In case there is a need of heating (cold resistance) for climatic zone AI, AII (prefer to TCVN 4088: 1985), FS is necessary.
- 3.1.9. When calculation of ventilation, air-conditioning and heating systems, basing on type and objective to:
  - a. Calculate the parameters under grade III – when design of general ventilation systems (by natural or mechanical expulsive force) to play function of eliminating surplus heat or moisture, including simple cooling cases by adiabatic process.
  - b. Calculate the parameters under grade III in hot season and parameters under grade II in cold season of the year – when design of general ventilation to eliminate the toxic gas under grade I, 2, 3, 4 or to balance the exhaust air volume through local inspiration or inspiration through technology line (fire process, delivery by compressed air, dry, etc.), including design of cooling ventilation by adiabatic evaporation (water injection in room, in piping or in spray booth) as well as air-bathing by outdoor air.
  - c. Calculate the parameters under grade II – design of air-conditioning;
  - d. Calculate the parameters under grade II for cold season – design of air-heating as well as [air screen or heat screen](#);
  - e. Calculate the parameters under grade I – only design of air-conditioning with based technology requirements.

*Notes:*

*1. When design of ventilation and air-conditioning systems, only a part of daily time shall be used (only for night or some fixed hours in day) or some months in year, other parameters can be taken in stead of foregoing guidances.*

*2. Air volume needed to dilute explosive concentration in indoor atmospheric environment must be determined according to outside atmospheric parameter under grade I and II for calculation of the system.*

- 3.1.10. Natural room-crossing ventilation must be organized especially at night to cool the building roof including top ceiling floor and technical floors if allowed by operation condition.

- 3.1.11. For crane cabin in production rooms with high surplus heat, and radiation intensity exceeding  $330 \text{ kcal/m}^2\cdot\text{h}$ , or when toxic concentration in air around cabin exceeding allowable limited concentration, air-ventilation or air-conditioning must be provided. For cabin located in production rooms under grade A, B and F as well as toxic gas under grade I, 2 releasing but without filtering facilities in air, air-bathing supply systems or air-conditioning by outdoor dust-filtered air must be designed.

Total circulation can be used when atmospheric environment around cabin without toxic gas or only toxic gas under grade 3, 4 with lower concentration than allowable limit.

- 3.1.12. Ventilation, air-conditioning and heating systems shall be designed with antivibration and antinoise methods to ensure the allowable noise standards.
- 3.1.13. In rooms with area of more than  $40\text{m}^3$  for each working people and with window or skylight, if without toxic gas or unpleasant smell emitted, natural ventilation through window or skylight can be acceptable.

*Note: The concept "without unpleasant smell emitted" should be understood as volume of noxious substances emitted at the same time from technological equipments shall not increase the noxious concentration in the environment which exceed the allowable limit.*

- 3.1.14. When design of ventilation, air-conditioning and heating systems, the pervasion condition of inside temperature, moisture and noxious substance (pervasion method and distribution) as well as building use condition must be taken into account. When design, the preventive measures against the pervasion of inside noxious gas and air transmission from rooms with high concentration of noxious gas to rooms with little or without noxious gas.
- 3.1.15. In design, it is popular to combine supplied ventilation and air-conditioning with air-heating systems.

For residential and public buildings and auxiliary house of enterprises, where occurs only one shift, the combination between supplied ventilation and air-conditioning with air-heating systems must be implemented with adequate basis.

### **3.2 Ventilation, air-conditioning and heating systems.**

- 3.2.1. The center supplied and exhausted ventilation or air-conditioning systems in production rooms without natural ventilation must be designed by at least two exhaust systems and two supply systems to ensure not under 50% of exchanged air volume during pause of one system.

When design only one supply system or one exhaust system or one group of air-conditioners, the provision of standby fan with automatic-operated electric motor is needed when main fan stops running or connected through header with neighbouring systems to ensure at least 50% of exchanged air flow rate when this fan system stops running.

*Note: The buildings and rooms are considered to be naturally ventilated if outdoor air is only supplied by mechanical ventilation or air-conditioning systems and without dedicated opening for airy purpose. The parts of the building which are not naturally ventilated (aerated) are distant from outside wall with airy opening of over 30m.*

- 3.2.2. In case air supply and exhaust fans stop working while open/close openings connected with other rooms ensuring adequate air supply and exhaust, the separated rooms without natural aeration due to technological conditions are permitted not to be installed with standby fans as stated in article 3.16 and be available with stand-by equipments for replacement of fan in the event of failure during 24 hours.
- 3.2.3. The air-conditioning systems (both center and local) with the task of maintenance of indoor microclimatic parameters through the year and all day long must be designed with at least 2 nos of AC.
- The AC capacity must be defined in a way that when one AC is out of order, the remaining air flow must ensure not smaller than 50% of calculated flow, and cooling capacity shall ensure indoor temperature at superior limit of comfortable zone ( $t=29.40^{\circ}\text{C}$ ) when outdoor air temperature is equal to calculated temperature according to article 3.1.9.
- Note: When all basis technology requirements are available for the stability of indoor parameters all day long and through the year, standby air-conditioner shall be acceptable.*
- 3.2.4. For rooms with possibility of short-term toxic gas inside (kitchen in the building, classroom, etc.), ventilation system with exchange air increasing structure for each short-term period shall be designed if there arises a real demand for environmental guaranty in accordance with standard.
- 3.2.5. Air-bathing supply systems are not allowed to be combined with supplied ventilation system.
- 3.2.6. For residential and public building and auxiliary house, ventilation shall be designed but draught resistance method is also needed.
- For multi-storey building (with or without air-conditioning system), vertical air shaft used for kitchen and toilet must be provided with mechanical vacuum fan.
- 3.2.7. Natural ventilation systems in production rooms with surplus heat in summer must be calculated according to difference on heat pressue equivalent to difference between indoor and outdoor temperature at parameter III, including air temperature increase according to height of production room.
- When calculation of natural ventilation, the impact of mechanical ventilation and impact of wind resistance must also be considered.
- 3.2.8. Natural ventilation systems of production rooms without surplus heat in summer through the year must be calculated according to wind impact.
- Calculated velocity in summer of the year shall be extracted according to TCVN 4088: 1985.
- 3.2.9. Local ventilation or center ventilation systems must be designed to discharge burned products of radiation heater using combustible gas to ensure the air environmental cleanness in working or serving area.
- 3.2.10. For dryer grade II or local dryer devices in air-conditioning system, water with invariable heat parameter must be provided.