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245

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THE EFFECT OF STREAMLINES OF WIND FLOW IN CALCULATION OF POLLUTION RE-ENTRY INTO BUILDINGS

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The existing procedures of calculating the atmospheric pollution in the places of air intake devices of the ventilation and air conditioning systems do not take into account the diversity of peculiarities of streamlining the buildings with complex configuration, the formation of circulation zones that to a greater degree determine the pollution level at a given point, the quality of incoming air and respectively the efficiency of the ventilation systems functioning.

The more stringent sanitary and hygienic requirements to the quality of the incoming air into houses and social and production premises lead to the necessity of diagnostic calculation of the pollutant concentration in the air-intake devices of the ventilation and air-conditioning systems, in the openings of the buildings with the aim to define their compliance with the norms and the sufficiency of the measures taken to reduce the emissions into the atmosphere.

Along with the meteorological parameters, wind flow characteristics, the atmospheric pollution level in the considered place depends on the architectural and planning decisions of the development, mutual positioning and characteristics of the pollution sources and air-intake devices, aerodynamics of buildings streamlining.

When the wind is streamlining buildings of various purposes the circulation zones with the high potential for pollution appear at the getting away edges. The task of the studies is to determine experimentally the borders and dimensions of the circulation zones, i.e. aerodynamics of flows and the general picture of their movement as well as of impurities emitted into the atmosphere. The experiments have been performed by physical modelling in the flume and in the direct flow wind tunnel with the open working part.

The experiments have been performed in the flume by making the flows visible with the help of the aniline paint solution injected by the syringe with too little momentum near the wooden models secured to its side wall.

The even field of water motion speeds has been created over the entire width of the flume before each series of experiments, the value of the flow velocity has been registered in the turbulent mode. The spread of the painted jets has been photographed.

The visual examinations and the analysis of photos show that in streamlining the separate building and depending on the ratio of its parameters the formation of the circulation zones is possible: by the windward wall the zone of overpressure is formed, over the entire roof and by the lee wall - the common zone, over part of the roof by windward wall - the windward zone and then behind the lee wall of the same building - the lee zone.

The circulation zones represent the zones bordering on the external fencing of the building and characterized by the reciprocating motion of the air masses and therefore

Proceedings of the Cold Climate HVAC '94 Conference

by the circulation of part of the impurities which get into these zones with their accumulation in comparison with the ambient air.

The dimensions of the circulation zones are rather stable and on the average they constitute: The zone of overpressure - H, where H is the height of the building, the windward zone is 2.5 H, the lee zone is 4H, and the common zone is 6H.

The three-dimensional study in the wind tunnel with the visualization of the flows by the test prod, which inserts the fumes of four-chlorine titanium into the determined point confirm the dimensions of these circulation zones which have been obtained in the plane flume. What is more, the presence of the face zones has been discovered, which by the site of their formation were divided into windward and lee or common zones. The change of the relative length of the prism bodies has serious influence on the value of resistance rate: the rate of the drag is reduced with the reduction of the relative length. This is explained by the fact that the streamlining of the body faces leads to the narrowing of getting away zone behind the body and to the increase of the absolute pressure in the circulation zone as compared with the bodies of great lengthening. In connection with it the drawing-in action of the leeward part of the poor-streamlined body decreases which reduces its resistance. Therefore the lesser is the size of the building in the direction perpendicular to the flow movement, the more increases the face zones value in the aired territory behind the building.

The quality-quantitative flow study in the circulation zones enable to work out in detail their structure. The air flow getting away from the lee edge of the building expands as it moves and organizes the boundary layer. The internal boundary of the deformation of the velocity field runs along the line with horizontal component of the air velocity equal to the wind flow velocity in front of the building. This boundary is sharply visually indicated in the flume and is of $6^0 - 8^0$ relative to the horizon.

The boundary layer altitude increase is subject to the linear manner and external boundary corresponds to the line on which horizontal component equals zero. The location of this line is defined by determining the point at which unsteady motion of the liquid in the flume is observed. This point locates the dimension of the zone along the flow. The influence of the flow turbulent characteristics on the dimensions of the circulation zones beyond the poor-streamlined bodies with given sharp edges and localized places of flow getting-away has not been detected. It is noted in document (ref. document 1) that the influence is not great therefore these parameters are excluded from the further consideration. For the case to be considered according to the external boundary inclination of 15⁰.

During the research in the wind tunnel the value of this external boundary inclination has been calculated by the coordinate values of the points located on the line of zero values of the flow velocity horizontal component. Such determined values have been in the range from 14^o to 16^o.

The described diagram of flows in the circulation zone occurring from the lee side of the building allows to suppose the action of the plane-parallel turbulent jet during getting away from the lee edge (roof) of the building. The features and patterns of spread of the plane-parallel turbulent jets have been theoretically substantiated by Mr. G.N. Abromovich (ref. document 2).

The velocity fields have been measured in the wind tunnel in the cross-sections of the specified zone to confirm this statement. The horizontal velocity component at the measured points has been determined by means of pneumometric tube secured in the traversing probe and by micro pressure gauge.

246

Proceedings of the Cold Climate HVAC '94 Conference

The results of the study, processed depending on the relative velocity flow, and location of the point at which the measurements have been taken showed that the experimental data were satisfactorily placed next to the theoretical curve calculated on the basis of Mr. Abromovich's materials. The deviations constitute from 10% to 15% which proves the competent uae of the specified theory for working out in detail the structure of flows in the zones and for development of the procedure for calculation of pollutant concentrations in them.

Reference:

1. S.M. Gorlin, S.P.Ziborova

"The Study of the Streamlining of Urban Buildings and their Elements"

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2. G.N. Abromovich

"The theory of the Turbulent Jets"

The Physics and Mathematics Publishing House, Moscow, 1987.

247