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Optimization and Experimental Validation of Air Ventilation Nozzle using MATLAB

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Abstract - *In the natural ventilation of building wind energy is used to drive air into building through small opening. In low velocity regime, continuity equation governs the nozzle processes. Optimization of nozzle shape is must as a requirement of large driving force as well as minimum energy losses due to stagnation and minimum air leakage from main air stream. In the present study, we are dealing with rectangular hyperbolic nozzles. Beta (β) is an angle between two asymptotes of rectangular hyperbola. This angle has a major influence on nozzle geometry. For analysis purposes β is limited in the range of 0^0 to 180^0 and Nozzle Inlet conditions of air are taken from standards as pressure 1 bar, temperature 308 K, wind velocity 3 m/s, density 1.123 kg/cubic meter in summer season for Ahmednagar city. In this case, Optimization of nozzle shapes is carried out for maximum driving force at the outlet of nozzle and minimum energy lost and minimum air leakage. Analytical results from MATLAB software for velocity, area, pressure, temperature, density distribution along the horizontal axis of the nozzle show that energy head loss and boosting of air is maximum at $\beta=0^0$,both continuously reducing up to $\beta=180^0$. Nozzle shapes when $\beta < 90^0$ having practical limit because of the leakage of airstream. But air leakages are maximum at $\beta=0$, then after it reduces up to $\beta=90^0$, then after no air leakages, Therefore unit rectangular hyperbolic nozzles (i.e. $\beta=90^\circ$) are optimum nozzle shape.*

Key Words: **Asymptotes[1], DBT[2], Natural Ventilation3, Nozzle[4], WBT[5]**

1. INTRODUCTION

An average person today spends about 90% of his time indoors. Therefore, it is important to maintain focus on a good and healthy indoor environment, but this does not exclude saving energy. To be more independent of the oil as an energy source and also to reduce the damaging outlets to the environment, an increasing use of sustainable technologies Such as solar energy, better use of daylight and use of natural ventilation is more and more often discussed when new buildings are designed. Due to complexity of building structure, rooms are not ventilated directly through windows opening. There is increasing awareness for the high energy usage in the buildings. Many buildings use mechanical air conditioning to regulate the internal environment, but even with energy efficient designs, they typically use around 230 KWh/m^2 of energy. However, in a number of buildings, alternative low energy systems use natural ventilation to significantly reduce the energy consumption. Research has developed a good understanding of the basic principles of natural ventilation within simple building structures. One of the key challenges now is concerned with understanding the subtleties of such flows within more complexes multiple storey buildings. Building ventilation by natural ventilation in which openings such as windows, ventilating shafts or ventilators are used to allow outside air to enter and inside air to leave the building. Pressure difference between outside air and inside air is a driving mechanism for the air to enter and leave the building. [1] Natural ventilation is the intentional flow of outdoor air through an enclosure under the influence of wind and thermal pressures through controllable openings. It can effectively control both temperatures and contaminants, particularly in mild climate. Temperature control by natural ventilation is often the only means of providing cooling when mechanical air-conditioning is not available. The arrangement, location and control of ventilation openings should combine the driving forces of wind and temperature to achieve desired ventilation rate and good distribution of fresh air through the building. Natural ventilation occurs according to the differences of pressure across the openings. This pressure difference is caused by ambient pressure and temperature differences between different openings of a buildings. The current drive for sustainable design has led to the need to focus on natural ventilation as a factor towards the reduction of greenhouse emissions.

1.1. Ventilation

Ventilation moves outside air from surrounding into a building, and distributes the air within the building equally. The general purpose of ventilation in buildings is to provide healthy air for breathing by both diluting the pollutants originating in the building and removing the pollutants from it.

Building ventilation has three basic elements:

(i) Ventilation rate — the amount of outdoor air that is provided into the space, and the quality of the outdoor air;

(ii) Airflow direction — the overall airflow direction in a building, which should be from clean zones to dirty zones; and (iii) Air distribution or Airflow pattern — the external air should be delivered to each part of the space in an efficient manner and the airborne pollutants

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