Theoretical Simulation and Practical Fabrication of a Novel Vertical Axis Fan

Li, Muyao (School: No. 2 High School of East China Normal University)

This novel invention of vertical axis fan is inspired by the structure of vertical axis wind turbines (VAWTs) to overcome the airflow limitation of conventional horizontal-axis fans and immobility of high ceiling fans. With multiple blades rotating around a vertical axis, the novel vertical axis fan inhales air from an axially hollow air inlet in the vertical direction and radiates it out uniformly in the radial direction in 360 degrees. The CFD simulation is used to determine the optimal arrangement and inclination angles of the blades, and the results show that radial blades with inner and outer inclination angles of respectively 15° and 90° provides maximum airflow and lower turbulent kinetic energy among various combinations. Also, the CFD simulation results illustrate that setting air deflectors with both 30° inclination angles surrounding the blades can further increase the total airflow by 5%. A vertical axis fan prototype is fabricated by integrating a 3D-printed fan body with the collapsible base of a commercially available fan, which enables the fan to be easily moved. According to the prototype test results, the relative error between simulations and real tests is no more than 7.2%. With concentrated inlet airflow and diffuse outgoing airflow, the novel fan body structure is more suitable than traditional ones in such applications as air purification, air cooling/heating, air humidification, etc. In the future, the vertical axis fan can be developed into a portable dual-functional machine with both air ventilation and wind power generation functions. Besides, a group of the vertical axis fans can also be arranged optimally in a certain formation at workplaces to make the airflow of the air-conditioner even and temperate.

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