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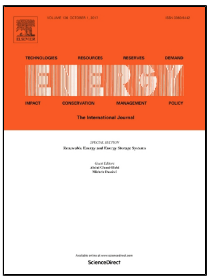

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# Investigation of Wake Characteristics of a Horizontal Axis Wind Turbine in Vertical Axis Direction with Field Experiments

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## HIGHLIGHTS

- Ultrasonic anemometer, three-cup type anemometer and wind vane were used
- The wind velocity deficit took the maximum value at $y/R$=0.50, $z/R$=-0.25
- Expansion of the wake flow was more remarkably generated in a high wind shear index
- Non-dimensional velocity ratio increased in the vertical direction from $y/R$ = 0.50, $z/R$ = -0.25
- Maximum deficit position moved to the positive direction of $z/R$ as vertical velocity increased

## ABSTRACT

The flow-field in the wake of Horizontal Axis Wind Turbine (HAWT) is affected by the turbulence intensity and wind shear in the natural environment. In this paper, the wind velocity distribution of HAWT in the vertical axis direction was investigated in field experiments. The test wind turbine was a three-bladed upwind horizontal type wind turbine with a variable pitch mechanism. The generator capacity of this wind turbine was 30 kW with the rotor diameter of 10.0 m. The three-cup type anemometers and arrowhead type wind vane were installed on the upstream of wind turbine to measure the reference wind. The after-stream measuring device which could be moved to any position by using a hand pallet truck was used to investigate the wake variation characteristics at multiple points. The observations of the wind turbine wake were discussed under the optimal operating condition, according to the maximum value of power coefficient. The results showed that, the turbulence intensity in the vertical direction was increased in the case of low wind shear index. Moreover, with the increase of the inflow velocity, the maximum velocity deficit position in the wake was moved in the positive direction of $z/R$.

*Keywords*: Horizontal Axis Wind Turbine (HAWT), wake measurement, velocity deficit, vertical axis direction, after-stream measuring device.

## NOMENCLATURE

| | |
|---|---|
| $a$ | inflow horizontal gradient |
| $C_p$ | power coefficient |
| $D$ | rotor diameter of wind turbine [m] |
| $h$ | height from the ground surface [m] |
| $H$ | hub height of wind turbine [m] |
| $L_1$ | distance from the reference anemometer to the center of wind turbine rotor [m] |
| $L_2$ | distance from the center of wind turbine rotor to the wake flow measurement device [m] |
| $n$ | wind shear index |
| $R$ | rotor radius of wind turbine [m] |

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