More Efficient Rooftop Ventilation Wind Generators with Topping Vertical Blades

Chonlatee Photong[1], Prompong Munmee[1], Adirek Wanthong[1]

Received: 30 December 2015; Accepted: 24 April 2016

Abstract

This paper presents a technique for improving the efficiency of an electrical generation system. Specifically, a rooftop ventilation wind generator using topping vertical blades is presented. A conventional 22-inch rooftop ventilator with 12 copper coils and 15 Neodymium magnetic sheets was investigated. The proposed ventilation wind generator had 4 vertical blades on its top and was tested with wind speeds of 2.4, 2.8 and 3.4 m/s. The experimental results show that the proposed generator can generate higher output rms phase voltages of 0.96, 1.48 and 1.90 V at rotational speeds of 37, 52 and 62 rpm compared to conventional generators of 0.70, 1.06 and 1.39 V at the rotation speeds of 26, 38 and 45 rpm, which is a 37-40% improvement in output voltage and a 36-42% improvement in rotational speed.

Keywords: ventilator wind generators, vertical blades, wind energy

Introduction

Using rooftop ventilators is one of the least expensive ways to dispose of heat from buildings to the outside air[1]. Most conventional rooftop ventilators utilize the concept of temperature difference between inside and outside buildings in coordination with the natural wind flow to cause their rotation and thus dispose of the indoor heat. Rotation of parts of rooftop ventilators therefore leads to the possibility of electricity generation based on Faraday's law of induction. Permanent magnetic sheets could be mounted on the rotating parts of the ventilators to provide a constant magnetic field and when these magnetic fields are managed to move across closed-loop inductive coils, electricity can be generated[2]. These kinds of ventilators are known as rooftop ventilation wind generators (RVWGs). There are few alternative technologies available for RVWGs[3-5].

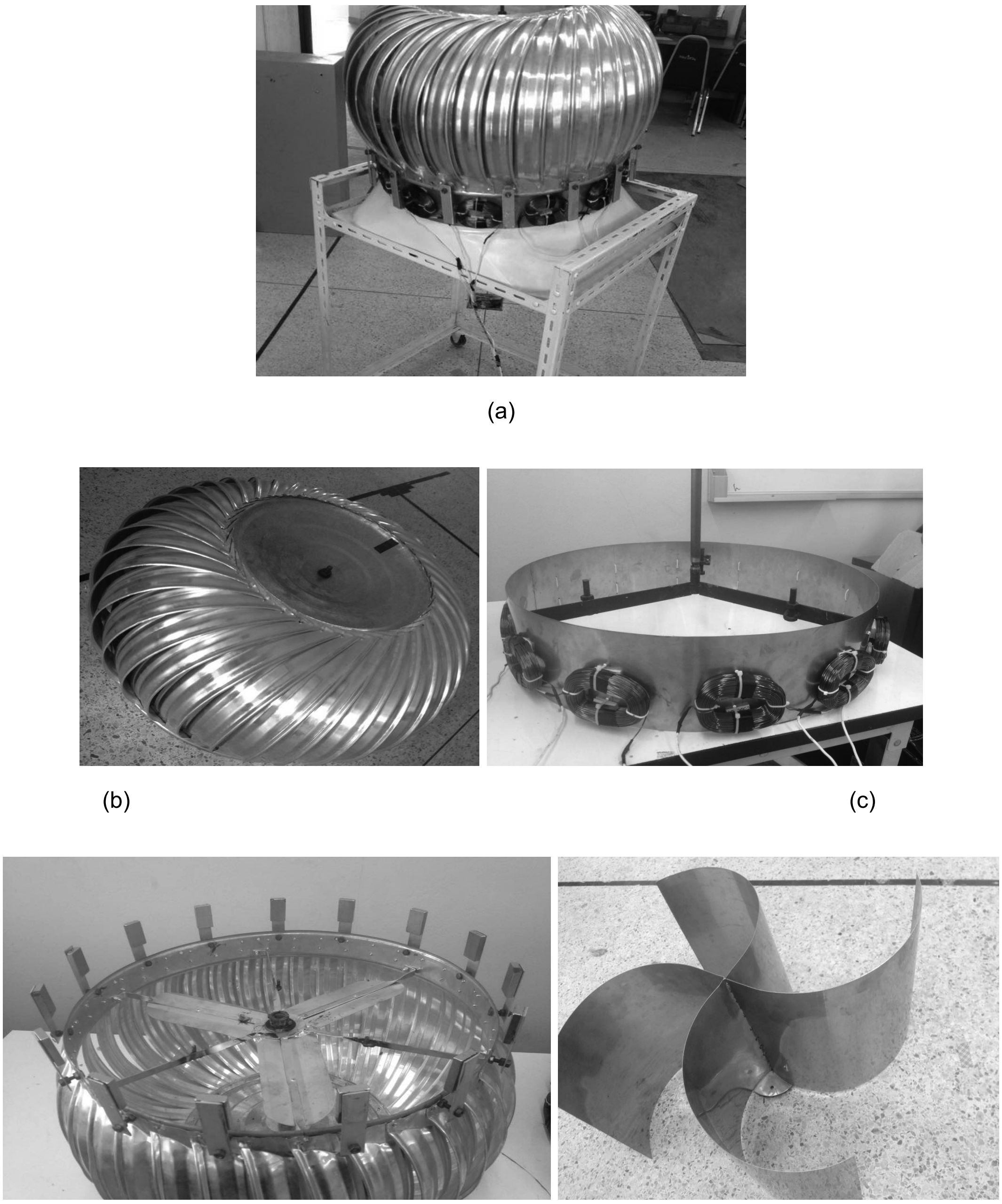
This paper proposes an alternative method to increase the electricity generation efficiency of RVWG, which is by installing vertical turbine blades on the top of the ventilators. The experimental results obtained from the proposed RVWG show that the proposed RVWG can increase amount of electricity by approximately 37-40% compared to conventional RVWGs, as well as provide greater capability of heat exhausting with a higher rotating speed of approximately 36-42% compared to conventional RVWGs. Structure and operation principle of the proposed wind generator are detailed in Section 2 and Section 3. The experimental results obtained from the proposed wind generator are presented and discussed in Section 4; following by the conclusions in Section 5.

Structure of the Proposed Rooftop Ventilation Wind Generator

(Figure 1a) shows the overall structure of the proposed rooftop ventilation wind generator (RVWG). The proposed RVWG consists of 4 components: a ventilator, copper coils, permanent magnetic sheets and vertical blades. A conventional aluminum ventilator with the most popular diameter of 22 inches was used (Figure 1b). Twelve sets of copper coils with 170 turns per coil, 24 degrees apart from each other (Figure 1c) were installed around the circular base of the ventilator. Fifteen sets of Neodymium permanent magnetic sheets were installed

[1] *Solar Energy and Energy Resources Research Unit, Faculty of Engineering, Mahasarakham University, Kham Riang, Kantarawichai, Maha Sarakham, 44150, Thailand chonlatee.p@msu.ac.th*

on the moving part of the ventilator, which were designed to rotate across all the copper coils angularly with the air gap between the magnetic sheets and coils of 1 cm (Figure. 1d). The magnetic sheets with the width, length and thickness of 2, 5 and 1 cm were used. Four vertical blades with dimensions shown in (Figure 1e) were additionally installed on the top of the ventilator.



(a) (b) (c) (d) (e)

Figure 1 Structure of the proposed rooftop ventilation wind generator: (a) overall structure; (b) a ventilator; (c) copper coils; (d) permanent magnetic sheets; (e) vertical blades

Operation Principle of the Proposed Rooftop Ventilation Wind Generator

Operation principle of the proposed rooftop ventilation wind generator can be described by referring to (Figure 1a-e). A conventional, low cost aluminum ventilator was used, which had functionality to dispose of the hot air inside the building to the outside as well as provide rotational movement for the magnetic sheets that were mounted on the edge of the moving part of the ventilator. The moving magnetic sheets generated magnetic fields and conducted electrons inside the closed-loop copper coils to move and finally generated electricity based on Faraday's low of induction. The additional vertical blades were installed on the top of the ventilator, which helped to increase rotation speed of the ventilator by increasing the attacking surface area for both wind from hot air and natural wind. Four vertical blades were used to allow all directions of wind (i.e. North, East, South and West) to rotate the blades easily even with very low wind speed.

Results and Discussions

(Figure 2) shows photographs of the experimental test systems. The conventional rooftop ventilation wind generator (RVWG) shown in (Figure 2a) was tested with the wind speeds of 2.4, 2.8 and 3.4 m/s generated from a fixed-position electric fan. The output rms voltage and speed of the RVWG then were measured and used for analysis and conclusions. Similarly, the proposed RVWG with additional vertical blades was tested with same input wind speeds and same test conditions as shown in (Figure 2b) The experimental results in terms of output voltage and rotational speed were examined.

(a) (b)

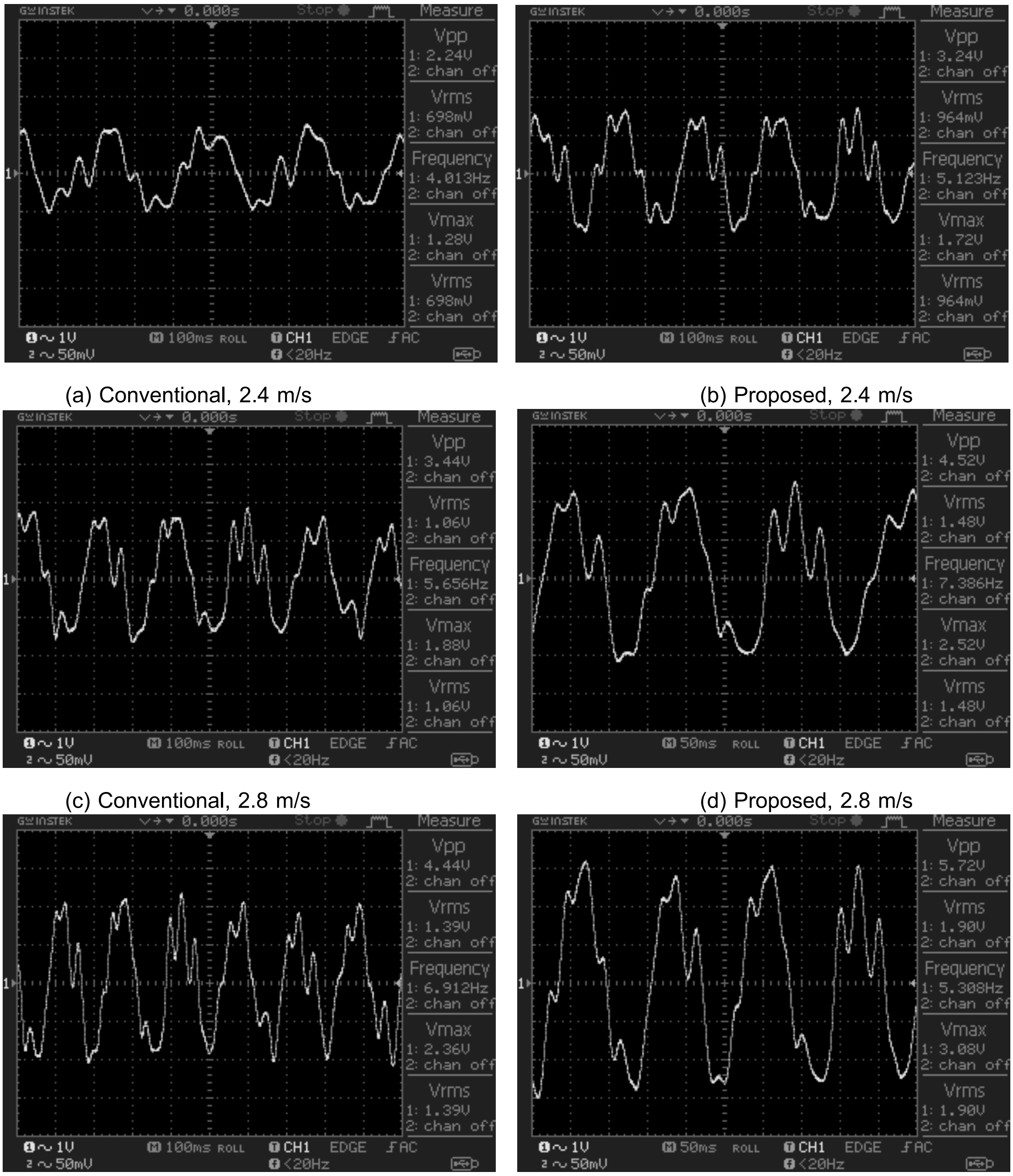
Figure 2 Photographs of the experimental test systems: (a) testing the conventional RVWG and (b) testing the proposed RVWG

1. Output Voltage

(Figure 3) shows compared results of the output voltage waveforms generated from the conventional RVWG (Figure 3a, c and e) and the proposed RVWG (Figure 3b, d and f) when testing with the wind speeds of 2.4, 2.8 and 3.4, respectively. The measured parametersfrom (Figure 3a-f) were reproduced in (Table 1). It can be seen that the output phase voltage levels of the proposed RVWG increase approximately 37-40% compared to the conventional RVWG.

Table 1 Measured output phase voltage at different wind speeds

Parameter	Conventional RVWG			Proposed RVWG (%change)		
	2.4 m/s	**2.8 m/s**	**3.4 m/s**	**2.4 m/s**	**2.8 m/s**	**3.4 m/s**
$V_{peak-peak}$(volt)	2.24	3.44	4.44	3.24 (+44.6%)	4.52 (+31.4%)	5.72 (+28.8%)
V_{rms} (volt)	0.70	1.06	1.39	0.96 (+37.1%)	1.48 (+ 39.6%)	1.90 (+36.7%)



(a) Conventional, 2.4 m/s (b) Proposed, 2.4 m/s

(c) Conventional, 2.8 m/s (d) Proposed, 2.8 m/s

(e) Conventional, 3.4 m/s (f) Proposed, 3.4 m/s

Figure 3 Output phase voltage waveforms: (a), (c) and (e) from conventional RVWG and (b), (d) and (f) from the proposed RVWG when testing with wind speed of 2.4, 2.8 and 3.4 m/s, respectively

2. Rotational Speed

(Table 2) shows measured rotational speeds of the rooftop ventilation wind generator (RVWG) for both the conventional RVWG and the proposed RVWG. The results show that adding vertical blades to the conventional RVWG could help to increase rotational speed approximately 36-42%. This would reflect the improved capability of exhausting the heat of the proposed RVWG compared to the conventional RVWG.

Table 2: Measured rotational speed of the conventional and proposed RVWG at different wind speeds

Parameter	Conventional RVWG			Proposed RVWG (%change)		
	2.4 m/s	2.8 m/s	3.4 m/s	2.4 m/s	2.8 m/s	3.4 m/s
Rotational Speed (m/s)	26	38	45	37 (+42.3%)	52 (+36.8%)	62 (+37.8%)

Conclusions

A more efficient rooftop ventilation wind generator using topping vertical blades has been proposed. Details of structure and operation principle of the proposed generator have been described. The experimental results in terms of generated output phase voltage and rotational speed obtained from both conventional and proposed generators have been presented and compared. The results show that output voltage and rotational speed of the proposed generators, when applied wind speeds of 2.4, 2.8 and 3.4 m/s, has been improved by approximately 37-40% and 36-42% compared to the conventional rooftop ventilation wind generator.

Acknowledgement

The authors would like to thank the Faculty of Engineering, Mahasarakham University, Thailand for the research grant (2015) and to Solar Energy and Energy Resources Research Unit, Faculty of Engineering, Mahasarakham University for test equipment and technical support.

References

[1] T. H. Sawyer and J. T. Reese, "Sports Facility Liability," *Journal of Physical Education*, *Recreation & Dance*, vol. 73, no. 9, pp. 10–11, 2002.

[2] R. A. Serway and L. D. Kirkpatrick, "Physics for Scientists and Engineers with Modern Physics," *Phys. Teach.,* vol. 26, no. 4, p. 254, 1988.

[3] Shun S. and Ahmed N.A, "Utilizing Wind and Solar Energy as Power Sources for hybrid Building Ventilation Device," *J. Renewable Energy*, Vol. 33, pp. 1392-1397, 2008.

[4] M. C. Hsieh, D. K. Jair, and H. M. Chou, "The Development of a New Type Rooftop Ventilator Turbine," *Engineering*, vol. 05, no. 10, pp. 16–20, 2013.

[5] M. Ismail and A. M. Abdul Rahman, "Rooftop Turbine Ventilator: A Review and Update," *Journal of Sustainable Development*, vol. 5, no. 5, Apr. 2012.