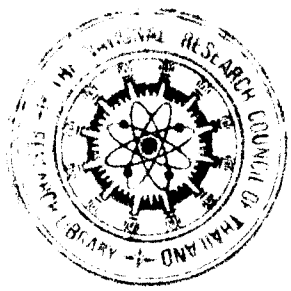
POWER QUALITY IMPROVEMENT FOR PERMANENT MAGNET PICO-HYDRO GENERATOR

BENTHILAVANH TESO

A Thesis Submitted to the Graduate School of Naresuan University
in Partial Fulfillment of the Requirements
for the Master of Science Degree in Renewable Energy
May 2011

POWER QUALITY IMPROVEMENT FOR PERMANENT MAGNET PICO-HYDRO GENERATOR



BENTHILAVANH TESO

A Thesis Submitted to the Graduate School of Naresuan University
in Partial Fulfillment of the Requirements
for the Master of Science Degree in Renewable Energy
May 2011

This thesis entitled "Power quality improvement for permanent magnet Pico-hydro generator" submitted by Benthilavanh Teso in partial fulfillment of the requirements for the Master of Science Degree in Renewable Energy is hereby approved.

..... Chair

(Pisit Maneechot, Ph.D.)

..... Committee

(Sukruedee Sukchai, Ph.D.)

..... Committee

(Assistant Professor Nipon Ketjoy, Dr.-Ing.)

..... Committee

(Assistant Professor Sakon Klongboonjit, Ph.D.)

Approved

.....

(Assistant Professor Kanungnit Pupatwibul, Ph.D.)

Dean of the Graduate School

May 2011

ACKNOWLEDGEMENT

I am deeply grateful to Dr.Sukruedee Sukchai, my thesis advisor, for her untired offering me some thoughtful and helpful advice in preparing and writing this thesis. I am very thankful to my co-advisor, Assistant Professor Dr.-Ing. Nipon Ketjoy, for his suggestions and constant support during this research. Moreover, I would like to thank Dr.Pisit Maneechot and Assistant Professor Dr.Sakon Klongboonjit, the internal examiner and external examiner of this thesis. Besides, I would like to thank all of my lecturers who have taught me for my knowledge and skills.

Finally I would like to thank the Naresuan University, especially School of Renewable Energy Technology for giving me the opportunity to be a part of their master's program and I would like to thank all my friends in School of Renewable Energy Technology for their kindness and friendship.

Benthilavanh Teso

Title	POWER QUALITY IMPROVEMENT FOR PERMANENT MAGNET PICO-HYDRO GENERATOR
Author	Benthilavanh Teso
Advisor	Sukrudee Sukchai, Ph.D.
Co-Advisor	Assistant Proffessor Nipon Ketjoy, Dr.-Ing.
Academic Paper	Thesis M.S. in Renewable Energy, Naresuan University, 2010
Keywords	Power quality, Pico-hydro

ABSTRACT

In this thesis, the power quality improvement for permanent magnet Pico-hydro generator (PMG) was studied by doing experiment of Pico-hydro generator laboratory with capacity of 1000 W, single phase voltage of 220 V, nominal speed of 1500 RPM and frequency of 50 Hz. Power quality improvement aimed to increase PMG output voltage in case of the output voltage is lower than 220 V and regulate the voltage and the frequency constantly (at EN 50160 standard of Provincial Electricity Authority 220 V ± 10% and 50 Hz ± 0.5 Hz) during on load operation or household load is varied. It also included 2 main proposes: 1st propose is to analyze the electrical characteristics of PMG and 2nd propose is to improve the power quality of PMG. Electrical characteristics analysis consists of: analyze the voltage and frequency of PMG during no load operation in the form of increasing frequency or speed to increase the output voltage, variation of voltage and frequency during on load operation, find the output voltage that is dropped or lower than 220 V during full load operation and find the actual capacity or active power, reactive power and apparent power of PMG. Power quality improvement used the data from electrical characteristics analysis to calculate for capacitance and for the setting values of the dummy load controller; power quality improvement consists of: parallel capacitor into the system to increase an output voltage and use dummy load controller (DLC) to regulate the voltage and the frequency constantly (at 220 V ± 10% and 50 Hz ± 0.5 Hz) during on load operation or household load is varied.

From experimental results found that: during no load operation, output voltage at frequency of 50 Hz was 238 V and the maximum output voltage was 319 V at a maximum frequency of 66.7 Hz. But during on load operation, at frequency of 50 Hz the output voltage was dropped to 192 V (lower than 220 V) because the PMG rotor is a permanent magnet that is unable to increase or decrease an output voltage. During on load operation, the output voltage and the frequency were not constant due to the varied household load. If the output voltage and the frequency were higher or lower than 220 V and 50 Hz such as: at load of 60 W, voltage of 281 V and frequency of 62.2 Hz; at load of 420 W, voltage of 162 V and frequency of 42.9 Hz, such voltage and frequency will affect the lifetime of appliances (lifetime of appliances will be shorter). During full load operation (on load operation at frequency of 50 Hz), actual capacity or active power, reactive power and apparent power were obtained 284 W, 198 VAR and 346 VA.

After electrical characteristics were already analyzed, some data from them such as: output voltage of 192 V, active power of 284 W and reactive power of 198 VAR were used to calculate for capacitance and for the setting values of dummy load controller. From the calculation for capacitance, capacitor 4 μF ± 5% 400 V could increase an output voltage from 192 V to 223 V and reactive power of PMG from 198 VAR to 237 VAR, but such capacitor is a capacitive load that decreases active power of PMG from 284 W to 245 W. When the household load was varied, dummy load controller could regulate the output voltage and the frequency nearly constantly; output voltage from 219 V to 227 V was in the range of 220 V ± 10% and frequency from 49.2 V to 50.8 Hz was nearly in the range of 50 Hz ± 0.5 Hz.

LIST OF CONTENTS

LIST OF CONTENTS (CONT.)

LIST OF TABLES

Table **Page**

LIST OF FIGURES

LIST OF FIGURES (CONT.)