DEVELOPMENT OF STATCOM TO IMPROVE VOLTAGE SAG DUE TO STARTING OF 5KILOWATT INDUCTION MOTOR

By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia in Fulfillment of the Partial Requirements for the Degree of Master of Science

March 2005

Dedicated to my parents, lovely brothers and sisters

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the partial requirements for the degree of Master of Science

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Chairman: Associate Professor Senan Mahmod, Ph D

Faculty : Engineering

Voltage sags are the most frequent power quality problems for many industrial processes. Due to the wide usage of sensitive electronic equipment in many fields as, electronic controller, communication and computers, even voltage sags which last for only few tenths of a second may cause production stops with considerable associated costs; these costs include production losses, equipment restarting, damaged or lower-quality product and reduced customer satisfaction.

An advanced static var compensator "STATCOM" is a reactive power source applied for the dynamic compensation in power systems to provide voltage support, increase transient stability margin and improve damping of power systems. This thesis investigates the possibility to develop a STATCOM that improve the voltage sag due to starting of 5-kilowatt induction motor. The setup of this implementation consists of inverter with a capacitor in its dc side, coupling transformers, and a control system.

The self commutate thyristor inverter has been used in this implementation has a simple switching On/Off control operation. It operates at low frequencies (most often around ac line frequency), and in the conducting state. Thyristors feature have very low losses, making them attractive devices to efficiently control very high currents and energies.

A capacitor in the dc side is charging via a diode bridge rectifier which is supplied from the same power source.

The STATCOM compensator based line commutation voltage source inverter for correcting voltage sag in steady-state condition has been simulated using Matlab, and a good improvement on voltage sag has been obtained by injecting reactive power into the system during sag period.

In order to verify the results obtained by the experiments. These results have been compared with simulation results and a good agreement has been obtained.

Abstrak tesis yang dikemukakan kepada senat Universiti Putra Malaysia sebagai memenuhi sebahagian keperluan untuk ijazah Master Sains

PEMBINAAN STATCOM UNTUK MEMPERBAIKI VOLTAN LENDUT DISEBABKAN OLEH PERMULAAN 5KILOWATT MOTOR ARUHAN BERKUASA TINGGI

Oleh

ABDURRAHMAN FETURI S. HUWEG

March 2005

Pengerusi: Profesor Madya Senan Mahmod, Ph. D.

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Voltan lendut adalah masalah yang ketara di dalam kualiti kuasa untuk kegunaan industri. Ia disebabkan oleh kegunaan bahan elektronik yang sensitif di dalam pelbagai bidang seperti pengawal elektronik, perhubungan, perkomputeran walaupun voltan lendut ini berlaku dalam jangka masa satu persepuluh saat dan ia akan menyebabkan pengeluaran terhenti yang memberi implikasi kepada kos pengeluaran di mana ia akan menyebabkan kekurangan pengeluaran, hidup semula mesin, kerosakan atau kualiti barang yang rendah yang akan menyebabkan pelanggan tidak puas hati.

Pemampas Statik (STATCOM) merupakan pembekal kuasa aktif kepada pemampas dinamik di dalam sistem kuasa dengan membekalkan bekalan voltan, meningkatkan kestabilan dan memperbaiki damping pada sistem kuasa. Tesis ini menyelidik tentang kemungkinan merekabentuk STATCOM untuk memperbaiki voltan lendut akibat

daripada memulakan 5-kilowatt motor yang berkuasa tinggi. pelaksanaan ujikaji ini mengandungi penyongsang dengan pemuat pada sebelah dc, pengubah gandingan dan sistem kawalan.

Penyongsang tiristor penukartertiban sendiri telah digunakan dalam projek ini yang mana ia memiliki keupayaan untuk membuka atau menutup kawalan operasi. Ia beroperasi pada frekuensi yang rendah (dalam lingkungan frekuensi talian AC dalam) dan keadaan pengaliran. Sifat tiristor mempunyai kehilangan yang rendah di mana ia merupakan alat yang memberi kecekapan pengawal yang tinggi untuk arus dan tenaga. Pemuat dc dicas dari penerus jejambat diod yang mana dibekalkan pada punca yang sama.

Pemampas static STATCOM dengan berasaskan penukar sumber voltan penukarterbitan sendiri untuk mengatasi voltan lendut di dalam keadaan pegun telah disimulasi menggunakan Matlab dan nasil yang didapati adalah sangat baik iaitu dengan kuasa reaktif disuntik ke dalam sistem semasa voltan lendut berlaku.

Untuk mengesahkan keputusan yang diperolehi melalui ujikaji, keputusan ujikaji telah dibandingkan dengan keputusan simlasi. Simulasi dan hasil yang diperolehi didapati hampir sama.

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Last but certainly not least, I would like to deeply acknowledge my parents, brothers and sisters for their continuous support, best wishes, love, and encouragement through my life.

I certify that an examination committee has met on 25th of March 2005 to conduct the final examination of Abdurrahman Feturi S. Huweg on his Master of Science thesis entitled "Development of STATCOM to Improve Voltage Sag Due to Starting of 5kilowatt Induction Motor" in accordance with Universiti Putra Malaysia (higher Degree) Act 1980 and Universiti Pertanian Malaysia (higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. The Committee Members for the candidate are as follows:

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This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirements for the degree of Master of Science. The members of the Supervisory Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for equations and citations, which have been duly acknowledged. I also declare that it has not been previously or currently submitted for any other degree at UPM or other institutions.

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ABDURRAHMAN FETURI S. HUWEG

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