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ENHANCEMENT OF POWER QUALITY BY USING DPFC

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ABSTARCT

UPFC is the most comprehensive multivariable flexible ac transmission system (FACTS) controller. Simultaneous control of multiple power system variables with UPFC posses enormous difficulties. This paper proposes a new real and reactive power coordination controller for a unified power flow controller (UPFC). The basic control for the UPFC is such that the series converter of the UPFC controls the transmission line real/reactive power flow and the shunt converter of the UPFC controls the UPFC bus voltage/shunt reactive power and the DC link capacitor voltage. In steady state, the real power demand of the series converter is supplied by the shunt converter of the UPFC. To avoid instability/loss of DC link capacitor voltage during transient conditions, a new real power coordination controller has been designed.

The need for reactive power coordination controller for UPFC arises from the fact that excessive bus voltage (the bus to which the shunt converter is connected) excursions occur during reactive power transfers. A new reactive power coordination controller has been designed to limit excessive voltage excursions during reactive power transfers. The shunt converter of the UPFC controls the UPFC bus voltage/shunt reactive power and the dc link capacitor voltage. The series converter of the UPFC provides simultaneous control of real and reactive power flow in the transmission line the shunt converter has been modeled as a 4-module converter. The series converter consists of two sets of converters. One set of converter is used for the real power flow control and the other set of converter is used for the reactive power flow control. Recent advances in high voltage IGCT technology allow for higher

switching frequencies with lower losses. This allows for practical implementation of PWM control. The switching frequency for the converters has been chosen to be nine times the fundamental. Here we use matlab/simulink for the simulation purpose and outputs are verified in the scope.

1.INTRODUCTION

UPFC is the most comprehensive multivariable flexible ac transmission system (FACTS) controller. Simultaneous control of multiple power system variables with UPFC posses enormous difficulties. In addition, the complexity of the UPFC control increases due to the fact that the controlled and the control variables interact with each other.

UPFC which consists of a series and a shunt converter connected by a common dc link capacitor can simultaneously perform the function of transmission line real/reactive power flow control in addition to UPFC bus voltage/shunt reactive power control. The shunt converter of the UPFC controls the UPFC bus voltage/shunt reactive power and the dc link capacitor voltage. The series converter of the UPFC controls the transmission line real/reactive power flows by injecting a series voltage of adjustable magnitude and phase angle. The interaction between the series injected voltage and the transmission line current leads to real and reactive power exchange between the series converter and the power system. Under steady state conditions, the real power demand of the series converter is supplied by the shunt converter. But during transient conditions, the series converter real power demand is supplied by the dc link capacitor.

If the information regarding the series converter real demand is not conveyed to the shunt converter control system, it could lead to collapse of the dc link capacitor voltage and subsequent removal of UPFC from operation. Very little or no attention has been given to the important aspect of coordination control between the series and the shunt converter control systems. The real power coordination discussed is based on the known fact that the shunt converter should provide the real power demand of the series converter. In this case, the series converter provides the shunt converter control system an equivalent

IJMTARC – VOLUME – V – ISSUE – 20 , DEC , 2017 ISSN: 2320-1363

shunt converter real power reference that includes the error due to change in dc link capacitor voltage and the series converter real power demand. The control system designed for the shunt converter in causes excessive delay in relaying the series converter real power demand information to the shunt converter. This could lead to improper coordination of the overall UPFC control system and subsequent collapse of dc link capacitor voltage under transient conditions. In this paper, a new real power coordination controller has been developed to avoid instability/excessive loss of dc link capacitor voltage during transient conditions.

In contrast to real power coordination between the series and shunt converter control system, the control of transmission line reactive power flow leads to excessive voltage excursions of the UPFC bus voltage during reactive power transfers. This is due to the fact that any change in transmission line reactive power flow achieved by adjusting the magnitude/phase angle of the series injected voltage of the UPFC is actually supplied by the shunt converter. The excessive voltage excursions of the UPFC bus voltage is due to absence of reactive power coordination between the series and the shunt converter control system. This aspect of UPFC control has also not been investigated. A new reactive power coordination controller between the series and the shunt converter control system has been designed to reduce UPFC bus voltage excursions during reactive power transfers.

In this paper, a UPFC control system that includes the real and reactive power coordination controller has been designed and its performance evaluated.

2.POWER QUALITY PROBLEMS

For the purpose of this article, we shall define power quality problems as:

‘Any power problem that results in failure or mis operation of customer equipment, manifests itself as an economic burden to the user, or produces negative impacts on the environment.’

IJMTARC – VOLUME – V – ISSUE – 20 , DEC , 2017 ISSN: 2320-1363

When applied to the container crane industry, the power issues which degrade power quality include:

• Power Factor

• Harmonic Distortion

• Voltage Transients

• Voltage Sags or Dips

• Voltage Swells

The AC and DC variable speed drives utilized on board container cranes are significant contributors to total harmonic current and voltage distortion. Whereas SCR phase control creates the desirable average power factor, DC SCR drives operate at less than this. In addition, line notching occurs when SCR's commutate, creating transient peak recovery voltages that can be 3 to 4 times the nominal line voltage depending upon the system impedance and the size of the drives. The frequency and severity of these power system disturbances varies with the speed of the drive. Harmonic current injection by AC and DC drives will be highest when the drives are operating at slow speeds. Power factor will be lowest when DC drives are operating at slow speeds or during initial acceleration and deceleration periods, increasing to its maximum value when the SCR's are phased on to produce rated or base speed.

Above base speed, the power factor essentially remains constant. Unfortunately, container cranes can spend considerable time at low speeds as the operator attempts to spot and land containers. Poor power factor places a greater kVA demand burden on the utility or engine-alternator power source. Low power factor loads can also affect the voltage stability which can ultimately result in detrimental effects on the life of sensitive electronic equipment or even intermittent malfunction. Voltage transients created by DC drive SCR line notching, AC drive voltage chopping, and high frequency harmonic voltages and currents are all significant sources of noise and disturbance to sensitive electronic equipment.

3.THE BENEFITS OF POWER QUALITY

IJMTARC – VOLUME – V – ISSUE – 20 , DEC , 2017

ISSN: 2320-1363

Power quality in the container terminal environment impacts the economics of the terminal operation, affects reliability of the terminal equipment, and affects other consumers served by the same utility service. Each of these concerns is explored in the following paragraphs.

ECONOMIC IMPACT

The economic impact of power quality is the foremost incentive to container terminal operators. Economic impact can be significant and manifest itself in several ways:

A. POWER FACTOR PENALTIES

Many utility companies invoke penalties for low power factor on monthly billings. There is no industry standard followed by utility companies. Methods of metering and calculating power factor penalties vary from one utility company to the next. Some utility companies actually meter kVAR usage and establish a fixed rate times the number of kVAR-hours consumed. Other utility companies monitor kVAR demands and calculate power factor. If the power factor falls below a fixed limit value over a demand period, a penalty is billed in the form of an adjustment to the peak demand charges. A number of utility companies servicing container terminal equipment do not yet invoke power factor penalties.

4.STATCOM:

In 1999 the first SVC with Voltage Source Converter called STATCOM (STATic COMpensator) went into operation. The STATCOM has a characteristic similar to the synchronous condenser, but as an electronic device it has no inertia and is superior to the synchronous condenser in several ways, such as better dynamics, a lower investment cost and lower operating and maintenance costs.

A STATCOM is build with Thyristors with turn-off capability like GTO or today IGCT or with more and more IGBTs. The static line between the current limitations has a certain steepness determining the control characteristic for the voltage.

The advantage of a STATCOM is that the reactive power provision is independent from the actual voltage on the

IJMTARC – VOLUME – V – ISSUE – 20 , DEC , 2017

ISSN: 2320-1363

connection point. This can be seen in the diagram for the maximum currents being independent of the voltage in comparison to the SVC. This means, that even during most severe contingencies, the STATCOM keeps its full capability.

In the distributed energy sector the usage of Voltage Source Converters for grid interconnection is common practice today. The next step in STATCOM development is the combination with energy storages on the DC-side. The performance for power quality and balanced network operation can be improved much more with the combination of active and reactive power.

V.SIMULATION RESULTS:

Fig : Model File:

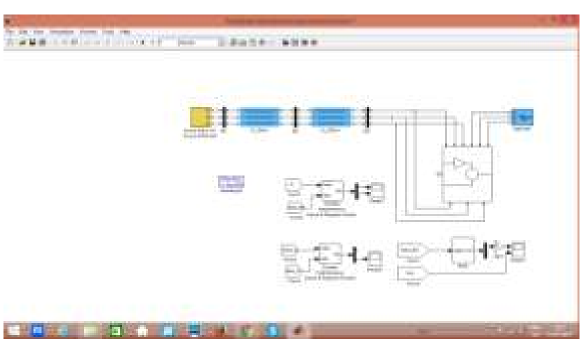
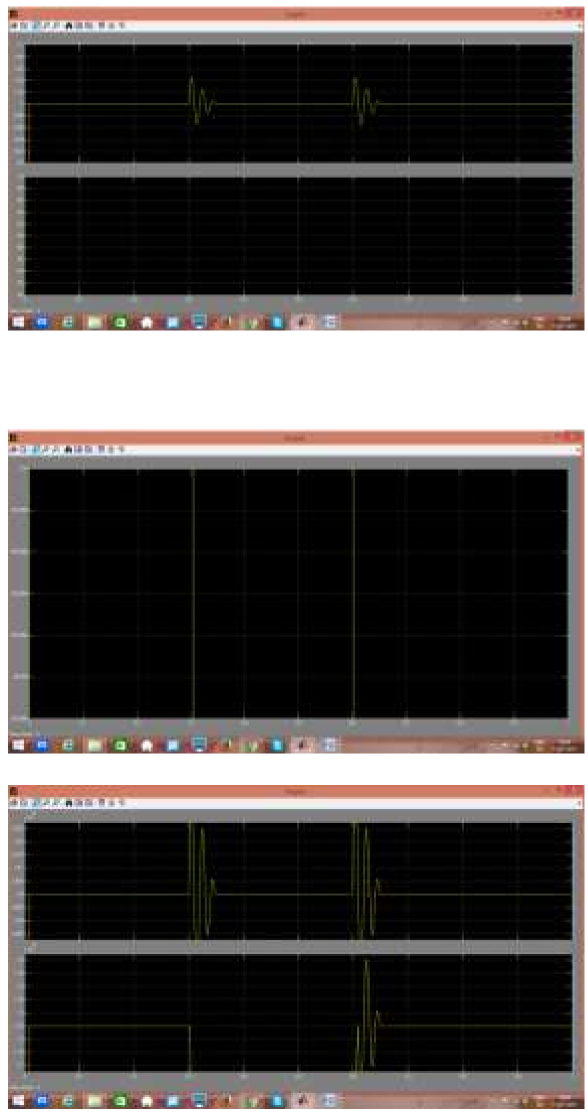


Fig: SIimulation Wave forms



. Matlab is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include Math and computation Algorithm development Data acquisition Modeling, simulation, and prototyping Data analysis, exploration, and visualization Scientific and engineering graphics Application development, including graphical user interface building.

Matlab is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar no interactive language such as C or FORTRAN.

Simulink is a tool used to visually program a dynamic system (those governed by Differential equations) and look at results. Any logic circuit, or control system for a dynamic system can be built by using standard building blocks available in Simulink Libraries.

Various toolboxes for different techniques, such as Fuzzy Logic, Neural Networks, dsp, Statistics etc. are available with Simulink, which enhance the processing power of the tool. The main advantage is the availability of templates / building blocks, which avoid the necessity of typing code for small mathematical processes.

VI CONCLUSION

This paper has presented a new real and reactive power coordination controller for a UPFC. The basic control strategy is such that the shunt converter of the UPFC controls the UPFC bus voltage/shunt reactive power and the dc link capacitor voltage. The series converter controls the transmission line real and reactive power flow. The contributions of this work can be summarized as follows.

Two important coordination problems have been addressed in this paper related to UPFC control. One, the problem of real power coordination between the series and the shunt converter control system. Second, the problem of excessive

IJMTARC – VOLUME – V – ISSUE – 20 , DEC , 2017

ISSN: 2320-1363

UPFC bus voltage excursions during reactive power transfers requiring reactive power coordination.

Inclusion of the real power coordination controller in the UPFC control system avoids excessive dc link capacitor voltage excursions and improves its recovery during transient conditions. MATLAB simulations have been conducted to verify the improvement in dc link voltage excursions during transient conditions. Significantly reducing UPFC bus voltage excursions during reactive power transfers. The effect on transmission line reactive power flow is minimal. MATLAB simulations have shown the improvement in power oscillation damping with UPFC.

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IJMTARC – VOLUME – V – ISSUE – 20 , DEC , 2017

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