Design Of Three Phase Three Wire Thyristor Controlled Lc Compensator To Mitigate Reactive Power Loss In Smartgrid

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Abstract - The phenomenon of harmonic currents injection by the SVCs was firstly presented in 1985. However, there was no solution provided at that time. Parallel combination of SVC and passive power filter (SVC+PPF) to reduce the harmonic currents injection by the SVC. However, the oscillating time and cost of these combined systems can be significantly increased. The combined systems of the SVC and STATCOM compensate both the reactive power and harmonic currents of the nonlinear loads. By doing so, the initial cost of the combined systems can be very high. In this paper, a thyristor controlled LC (TCLC) compensator is proposed for dynamic reactive power compensation in smart grid. The simulations will be compared with traditional compensation methods. The effectiveness of TCLC performance can be implemented using Matlab Simulink.

Key Index - Thyristor controlled LC (TCLC), reactive power compensation, harmonic reduction.

I. INTRODUCTION

The Smart grid, regarded as the next-generation power grid, is considered as a promising solution for energy crisis. However, the development of smart grid brings many new challenges for power quality [1], [2]. Compared with traditional grid, the smart grid requires substantial renewable resources like the wind energy [3], [4]. And the high demand of reactive power is one of the major power quality issues of wind farms. The large reactive power normal draws more reactive current which results in either increasing the cost or lowering the transmission capacity.

Therefore, the installation of the dynamic reactive power compensators can be one of the solutions for the above power quality issue. The thyristor based static var compensators (SVCs) made up of fixed capacitors and thyristor-controlled reactors (FC-TCRs) can dynamically compensate reactive power by controlling its firing angles. However, during the operation of FC-TCRs, low-order harmonic currents are generated, which can deteriorate the system performances [5]–[8]. Later on, the STATCOMs were proposed for reactive power compensation with faster response and less harmonic currents injection [9]–[12]. However, under the same VA rating, the SVCs are much cheaper (about 30% cheaper) than the STATCOMs [13], [14]. Therefore, SVCs still have promising potential to be further investigated whether the harmonic currents injection can be minimized.

II.FACTS DEVICES

Flexible AC Transmission Systems, called FACTS, got in the recent years a well known term for higher controllability in power systems by means of power electronic devices. Several FACTS-devices have been introduced for various applications worldwide. A number of new types of devices are in the stage of being introduced in practice. Even more concepts of configurations of FACTS-devices are discussed in research and literature. In most of the applications the controllability is used to avoid cost intensive or landscape requiring extensions of power systems, for instance like upgrades or additions of substations and power lines. FACTS-devices provide a better adaptation to varying operational conditions and improve the usage of existing installations.

III. WIND ENERGY

Wind power is the conversion of wind energy into a suitable form of energy, such as using wind turbines to generate electricity, windmills for mechanical power, wind pumps for water pumping, or sails to propel ships. The total amount of economically extractable power available from the wind is considerably more than present human power use from all sources. Wind power, as an alternative to fossil fuels, is abundant, renewable, widely spread, clean, and produces no greenhouse gas emissions during operation. Wind power is the world‘s rapid growing source of energy.

The majority of electricity is generated by burning coal, rather than more eco-friendly methods like hydroelectric power. This use of coal causes untold environmental damage through CO_2 and other toxic emissions. The energy sector is by far the biggest source of these emissions, both in the India and globally, and if we are to tackle climate change it is clear we need to move away from burning limited fossil fuel reserves to more sustainable and renewable sources of energy. Wind power has many advantages that make it a lucrative source of power for both utility-scale and small, distributed power generation applications. Wind turbines produce electricity by using the power of the wind to drive an electrical generator. Passing over the blades, wind generates lift and exerts a turning force. The rotating blades turn a shaft inside the nacelle, which goes into a gearbox. The gearbox adjusts the rotational speed to that which is appropriate for the generator, which uses magnetic fields to convert the rotational energy into electrical energy. The power output goes to a transformer, which converts the electricity from the generator at around 700V to the appropriate voltage for the power collection system, typically 33 kV.

IV. SMART GRID

With the growing ultimatum of electrical power, Quality of Service (QoS) and continuity of supply has been the utmost primacy for all major power utility sectors across the world, prior to the global market strategy. Smart Grid is predominantly proposed as the quantum leap in harnessing communication and information technologies to enhance grid reliability, and to enable integration of various smart grid resources such as renewable energy, demand response, electric storage and electric transportation. It allow greater competition between the providers, enabling greater use of intermittent power resources, establishing the wide area automation and monitoring capabilities needed for both bulk transmission over wide distances and distributed power generation, empowering more efficient outage management, streamline back office operations, aiding the use of market forces to drive retail demand response and energy conservation. Smart Grid technology underscores factors like policies, regulation, and efficiency of market, costs and benefits, and services that normalizes the marketing strategy, by restructuring the global power scenario in a very dynamic approach. In addition to this, the concerns like secure communication, standard protocols, advance database management and efficient architecture with ethical data exchange, adds to its requisites. The development of Information and Communication Technology (ICT) has updated the technology by supporting dynamic real-time two-way energy and information flow, facilitating the integration of renewable energy sources into the grid, empowering the consumer with tools for optimizing their energy consumption, by introducing Advance Metering Infrastructures (AMI), Virtual Power Plant (VPP) and other such incipient implements [26]. In addition, it helps grid to continuously self-monitor and self-adjust to achieve self-healing function, so as to monitor all kinds of turbulences, carry on compensations, redeploy the power flow, avoid the intensification of accident and make each kind of different intelligent devices to realize the network communication topologies. Power engineers across the renderer have developed a curiosity in decarburizing the electrical power while minimizing the dependency of the fossils. Such interest has fortified the growth of renewable energy by ensuing the efficiency and economy of the power grids. Integrated distributed power sources, includes renewable energy such as Fuel cells, Photovoltaic cells, Wind turbine, Micro hydro generators etc. could prolific the needs like power stability, improve grid efficiency, recruit use of the Plug-in EVs, support customer in changing their energy usage patterns, by reduction in power consumption and saving money. High power electronics is also a key technology to build the smart grid technology in an eventual way by adding new DC grids and AC Var sources at the T&D level, serving as backbones and additional stability pillars to existing grids. Fig.4.1 visualizes a typical paradigm of Smart Grid Technology and its distinctive feature.

V. SIMULATION RESULTS

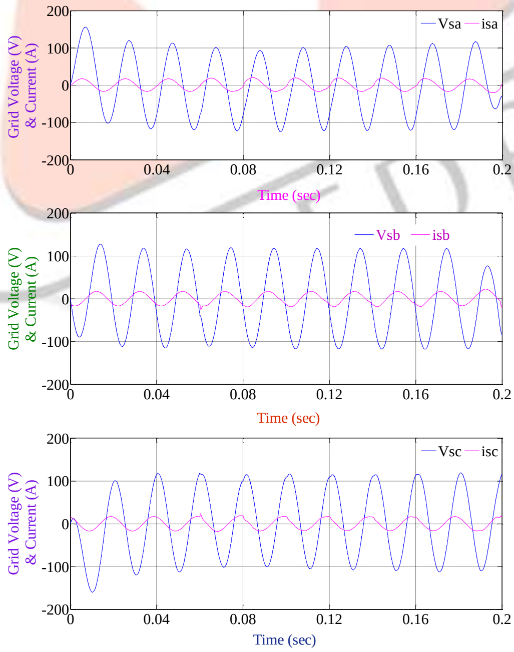

Fig.1: Inductive reactive power compensation using FC-TCR

In this Section, the proposed model of simulation results is presented for both inductive and capacitive load. In order to validate the proposed topology, simulation is carried out using the Matlab/Simulink. When FC-TCR is applied, Fig.1 and Fig.4, as shown in Fig.1 and Fig.4, Fig.7 (a) and (d), the system current total harmonic distortions (*THDisx*) are increased after FC-TCR compensation.When the TCLC compensator is applied, Figs.3 and 6. As shown in Figs.3 and 6, and Figs.7(c) and (f), the simulated system current *THDisx* of the worst phase are compensated to 7.5% for inductive case and 8.1% for capacitive case. Moreover, Figs.7(c) and (f) clearly show that much smaller 5th and 7th order harmonic currents are injected into the power grid system after TCLC compensation. In addition, Fig. 8 shows that the proposed TCLC compensator can dynamically compensate the inductive and capacitive reactive power.

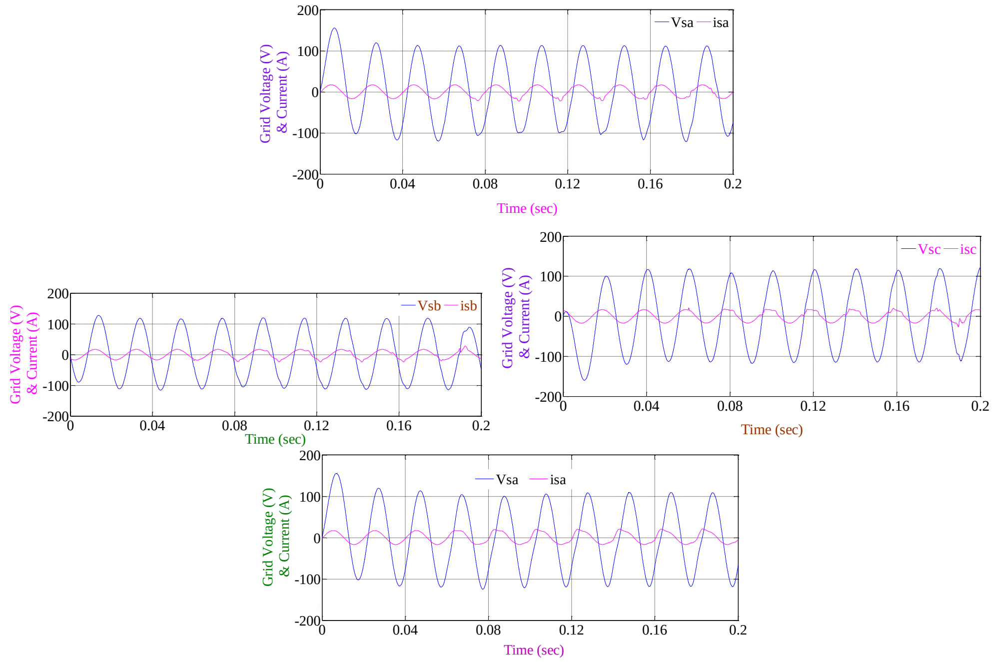

Fig.2: Inductive reactive power compensation using PPF

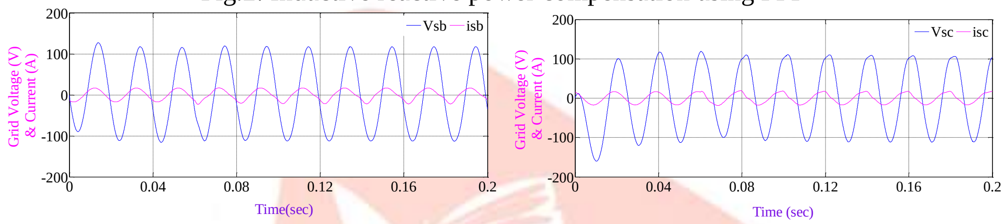

Fig.3: Inductive reactive power compensation using TCLC

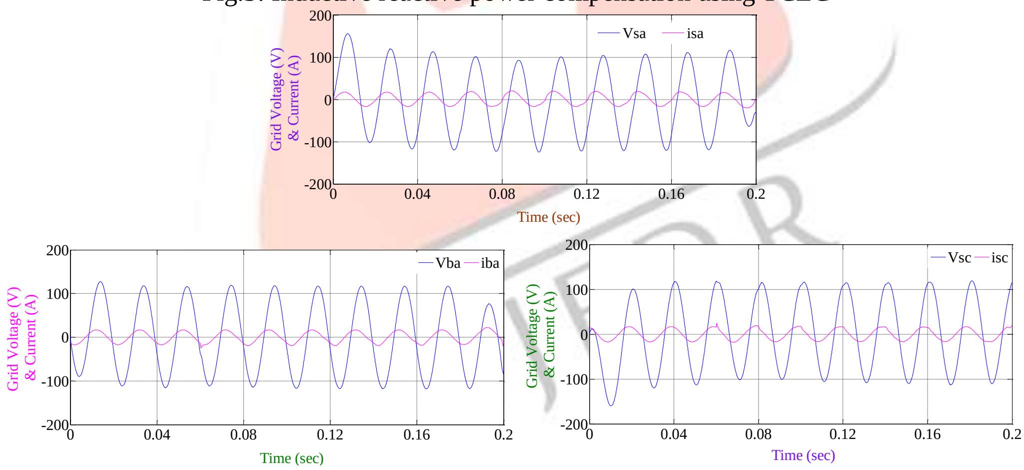

Fig.4: Capacitive reactive power compensation using FCTCR

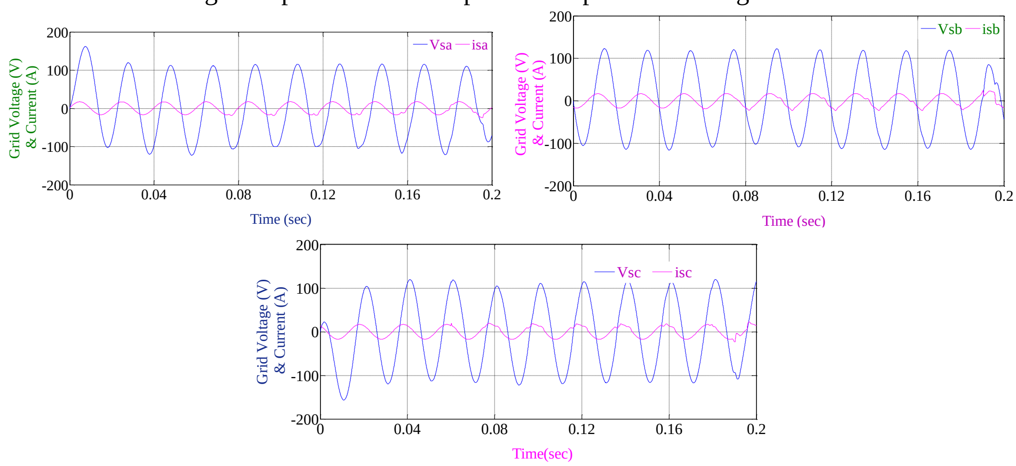

Fig.5: Capacitive reactive power compensation using PPF

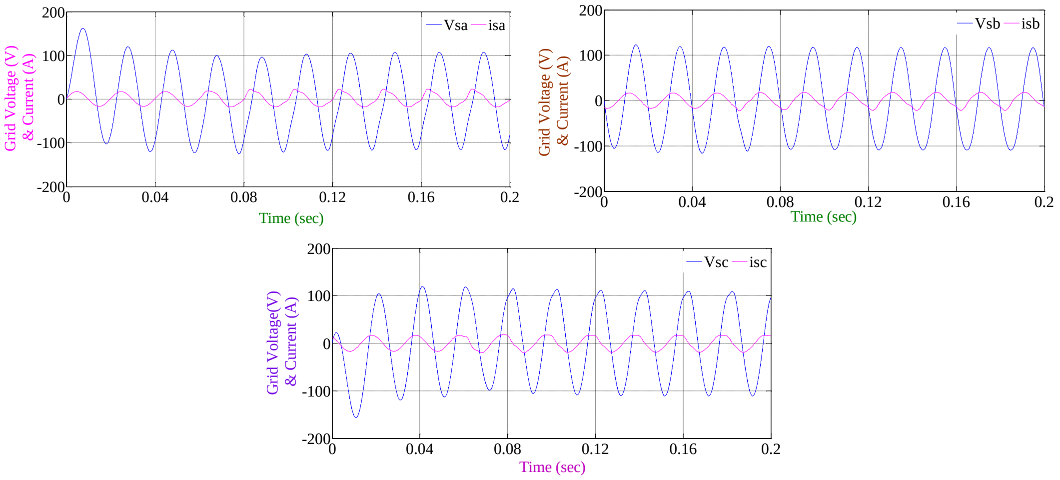

Fig.6: Capacitive reactive power compensation using TCLC

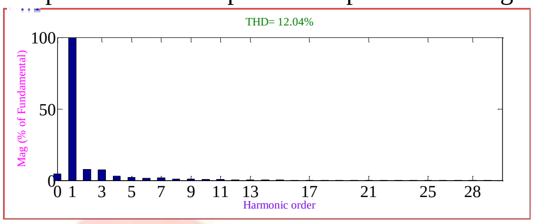

Fig.5.9a

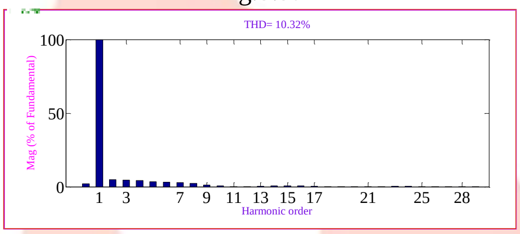

Fig.5.9b

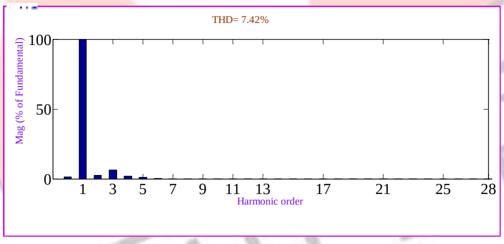

Fig.5.9c

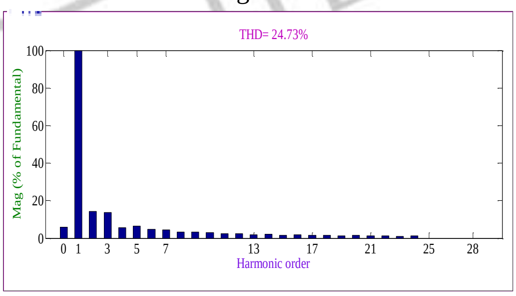

Fig.5.9d

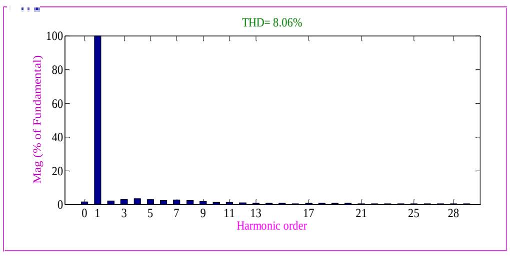

Fig.5.9e

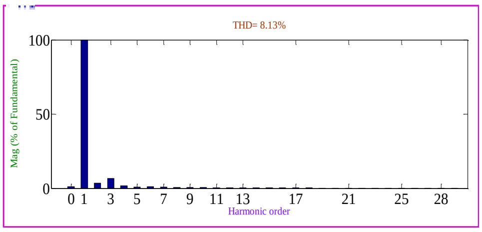

Fig.5.9f

Fig.7: Simulated grid systems current spectrums for inductive and capacitive reactive power compensation

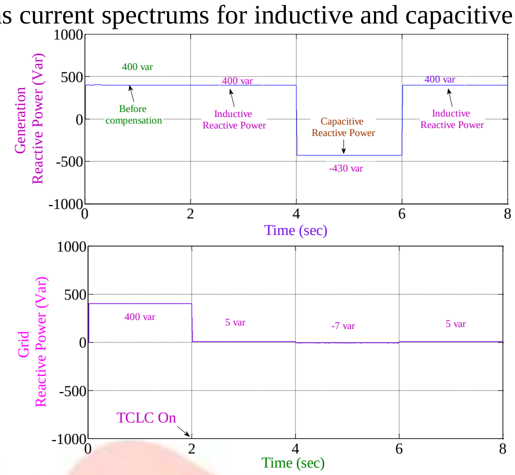

Fig.8: Simulation results of TCLC compensator dynamic reactive power compensation

VII CONCLUSIONS

In this paper, a three-phase three-wire TCLC compensator for dynamic reactive power compensation in a smart grid system is proposed and simulated. Therefore, the proposed TCLC can be considered as a cost-effective solution for reactive power compensation with less harmonic injection in smart grid system.

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