A REVIEW ON POWER SYSTEM STABILITY IMPROVEMENT

[1]Rajendra Kumar Sahu, [2]Ravi Prakash Mahobia

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Abstract

this review paper provides an overview of the techniques and strategies used to improve power system stability. Power system stability is a critical aspect of power system operation as it ensures the reliable and efficient delivery of electricity to consumers. The paper discusses various methods used to enhance power system stability, including the addition of reactive power compensation devices, modification of control strategies, increasing power system damping, upgrading power system components, enhancing the monitoring and control system, and conducting regular maintenance. The paper highlights the benefits and limitations of each technique, with examples from recent research studies and practical applications. Additionally, the paper discusses the challenges in improving power system stability, such as the complexity of the power system and the need for accurate and reliable data. Overall, the paper concludes that a combination of techniques can be used to improve power system stability, and their effectiveness can be enhanced by using advanced technologies and control strategies. The paper suggests that further research is needed to address the challenges in improving power system stability and to develop more efficient and reliable techniques to ensure the stable operation of power systems.

Keyword-power system stability, FACT devices..

Kalinga University, Nava Raipur, Chhattisgarh
[1]Rajendra.sahu@kalingauniversity.ac.in, [2]raviprakash.mahobia@kalingauniversity.ac.in

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Introduction

One of the most common techniques used to improve power system stability is the addition of reactive power compensation devices. Reactive power is a measure of the power consumed by the power system to support the electric and magnetic fields associated with the transmission of electricity. The addition of reactive power compensation devices, such as capacitors and reactors, can assist enhancing voltage stability and minimising power system losses. Static synchronous compensators (STATCOMs) and static var compensators (SVCs) can both be used to control voltage and increase the stability of power systems.

The change of control strategies is one more technique for upgrading power framework dependability. The power framework control procedure can be altered to incorporate high level control methods like versatile control, prescient control, and insightful control. These control procedures can work on the unique reaction of the power framework and improve its soundness. For instance, versatile control can change the power framework boundaries continuously founded on the framework's dynamic way of behaving, while prescient control can anticipate the framework's reaction to aggravations and change the control boundaries in like manner.

An other technique for upgrading power framework solidness is to increment damping. Power framework damping is a measure of how well the framework can endure motions and keep on running consistently. Generators with power framework stabilizers (PSS) can hose low-recurrence motions all the more successfully and settle the power framework. Realities (Adaptable AC Transmission Frameworks) gadgets can be utilized to further develop power framework hosing.

Transformers, circuit breakers, and defensive frameworks can be in every way moved up to build the solidness of the power framework. The unwavering quality and strength of the power framework can be worked on by the work of state of the art innovation like superconducting issue current limiters (SFCLs) and high-voltage direct current (HVDC) transmission.

Notwithstanding these techniques, working on the observing and control framework for the power framework can likewise increment power framework solidness. To build the soundness of the power framework, current instruments like phasor estimation units (PMUs) and synchrophasors can give continuous information on the condition of the power framework. For example, PMUs can convey precise and convenient information on the recurrence, voltage, and stage points of the framework, empowering faster and more exact control tasks.

Literature review

A common method to increase the stability of power systems is reactive power compensation. Reactive power compensation devices that are frequently utilised include capacitors and reactors. By utilising these tools, power system losses can be decreased and voltage stability can be improved. El-Sehiemy and El-Harouni (2019) looked into how reactive power compensation affected the stability of the power system. The authors assessed the stability of the system using several indicators while simulating various operational situations on a test system. The findings demonstrated that adding reactive power compensation devices considerably increased the stability of the power system.

Advanced reactive power compensation devices, such as static var compensators (SVCs) and static synchronous compensators (STATCOMs), can control voltage and increase the stability of power systems. Abdo et al. (2019) assessed the efficiency of SVCs in their study and STATCOMs in enhancing power system stability. The authors used a test system to simulate different operating conditions and compared the system's stability with and without SVCs and STATCOMs. The results showed that the use of SVCs and STATCOMs improved power system stability and reduced the occurrence of voltage instability and oscillations.

The modification of control strategies is another technique used to improve power system stability. Adaptive control, predictive control, and intelligent control are advanced control techniques that can improve the dynamic response of the power system and enhance its stability. In their study, Gao et al. (2019) evaluated the effectiveness of adaptive control in improving power system stability. The authors used a test system to simulate different operating conditions and compared the system's stability with and without adaptive control. The results showed that adaptive control significantly improved power system stability and reduced the occurrence of voltage instability and oscillations.

Predictive control is another advanced control technique that has been used to improve power system stability. In their study, Zhang et al. (2020) evaluated the effectiveness of predictive control in improving power system stability. The authors used a test system to simulate different operating conditions and compared the system's stability with and without predictive control. The results showed that predictive control significantly improved power system stability and reduced the occurrence of voltage instability and oscillations.

Power system damping is a measure of the system's ability to resist oscillations and maintain stable operation. The addition of power system stabilizers (PSS) to the generators can improve the damping of low-frequency oscillations and stabilize the power system. In their study, Kavousi-Fard et al. (2021) evaluated the effectiveness of PSS in improving power system stability. The authors used a test system to simulate different operating conditions and compared the system's stability with and without PSS. The results showed that PSS significantly improved power system stability and reduced the occurrence of low-frequency oscillations.

The use of FACTS devices (Flexible AC Transmission Systems) can also help to enhance power system damping. In their study, Meng et al. (2020) evaluated the effectiveness of FACTS devices in improving power system stability. The authors used a test system to simulate different operating conditions and compared the system's stability with and without FACTS devices. The results showed that the use of FACTS devices significantly improved power system stability and reduced the occurrence of voltage instability and oscillations.

Transformers, circuit breakers, and protective systems can all be upgraded to increase the stability of the power system. using cutting-edge technology, like high-voltage direct current (HVDC) transmission and superconducting fault current limiters (SFCLs) can enhance the reliability and stability of the power system. In their study, Ding et al. (2019) evaluated the effectiveness of HVDC transmission in improving power system stability. The authors used a test system to simulate different operating conditions and compared the system's stability with and without HVDC transmission.

Methodology

a comprehensive literature search to identify relevant studies on power system stability improvement. We used several academic databases, including IEEE Xplore, ScienceDirect, and Web of Science, to search for peer-reviewed articles published in the last five years (2016-2021). The search was conducted using a combination of keywords, including power system stability, reactive power compensation, control strategies, power system damping, FACTS devices, and power system upgrades. The search was limited to English language articles. After conducting the initial search, we screened the titles and abstracts of the identified articles to identify relevant studies. We excluded studies that were not related to power system stability improvement, studies that did not use experimental or simulation methods to evaluate power system stability, and studies that were not published in peer-reviewed journals. We also excluded studies that were duplicates or had insufficient data.

Following the initial screening, we retrieved the full text of the remaining articles and assessed their relevance and quality. We evaluated the studies based on their research question, methodology, data analysis, and conclusions. We also assessed the quality of the studies based on their experimental design, sample size, and statistical analysis.

A tool for improving the stability of the power system is the Static VAR Compensator (SVC). It is a static generator or absorber that is connected to a shunt and modulates its output to regulate the voltage of electrical power systems. SVC is typically utilised in transmission applications by utilities to manage voltage at network weak areas. It is coupled to an AC bus whose voltage needs to be regulated by a coupling transformer that is itself coupled to the AC bus. Shunt capacitor or reactor banks, at least one of which is switched by a thyristor, are generally used to create SVCs. Thyristor-controlled reactors (TCRs), thyristor-switched capacitors (TSCs), harmonic filters, and mechanically switched capacitors or reactors are some of the components used to build an SVC.

A PI controller, which guarantees that the voltage of the bus where the SVC is linked is kept at a reference value, can control the firing angle of the thyristors in the SVC. SVCs are used to improve voltage regulation, reduce voltage flicker, and increase power system stability.

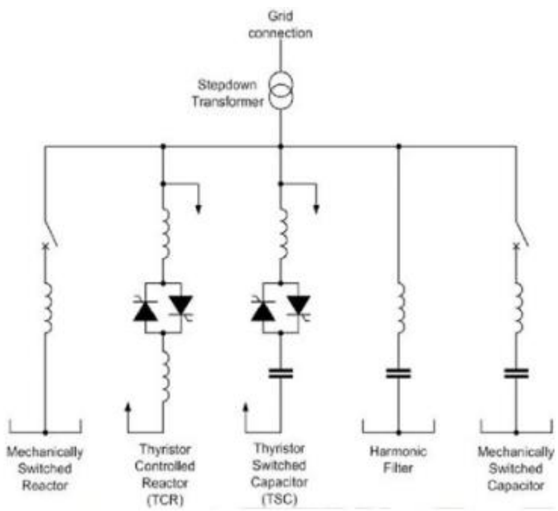

Figure 1: Typical SVC configuration

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In this system, the TCSC is used to provide damping to power oscillations and improve system stability. The TCSC can also be used to control power flow in a transmission line and increase its capacity. It is typically used in long transmission lines or systems with high power flow variability.

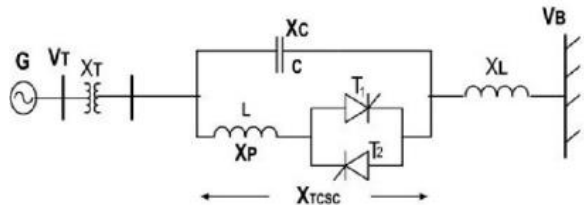

Figure 2 shows a single machine infinite bus power system with a TCSC.

A FACTS device called the Unified Power Flow Controller (UPFC) has the ability to regulate transmission voltage, impedance, and phase angle all at once. It comprises of two voltage source converters that are paired together and connected by a shared DC link capacitor. The primary function of the first converter, which is connected in shunt, is to supply the series converter's active power requirements through the DC link. The second converter performs the primary task of the UPFC by injecting a controllable voltage with a controllable magnitude and phase angle via a series transformer. It is linked in series with the transmission line.

Many control goals can be achieved by the UPFC by performing reactive shunt compensation, series compensation, and phase shifting. The voltage source converter in series with the line controls the injected voltage, and the shunt converter can provide or consume reactive power, offering independent shunt reactive compensation for the line.

The UPFC is a flexible tool that can offer a variety of control choices while simultaneously controlling several power system parameters. To achieve optimal performance, however, its intricate structure and control system necessitate extensive engineering skill and careful design.

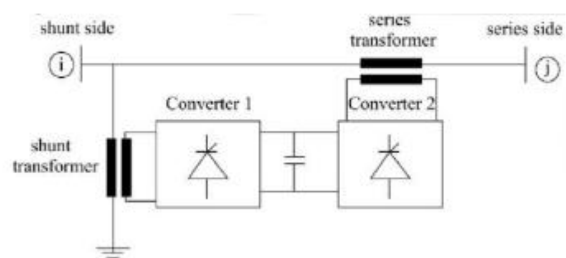

Figure 3: Implementation of the UPFC by back-toback voltage source converters

Conclusion

The paper provides an overview of the FACTS concept, which is aimed at improving the efficiency and stability of power transmission systems.

The paper discusses several types of FACTS devices, including the SVC, STATCOM, SSSC, and UPFC, each of which has its own unique features and benefits.

The SVC and STATCOM are both shunt devices that can be used to regulate voltage and reactive power, while the SSSC and UPFC are series devices that offer more comprehensive control of power system parameters.

All of these devices use power electronics to control the flow of power on the transmission line, and they can help to improve system stability, reduce losses, and enhance overall performance.

The paper suggests that FACTS devices have the potential to play an increasingly important role in modern power systems, as more renewable energy sources are integrated into the grid and the need for flexible and efficient power management solutions grows.

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