FACTS (Flexible AC transmission system) by using TCSC

Abstract

There is increasing demand for transmitting electrical power supply. The increase in power transmission also increases the complexity of electrical supply along with the increasing size. These results in the decrease of the performance of the power systems namely with load flow, power oscillations and voltage quality. Flexible ac transmission systems (FACTS) and High voltage direct current (HVDC) technologies offer some effective schemes to meet these demands. In recent years, FACTS technology has been considered as one of feasible planning alternative in India, to increase power grid delivery capability and remove identified network bottlenecks. An attempt is made in this paper to discuss the development and types of FACTS.

Introduction

The electricity supply industry is undergoing a profound transformation worldwide. Market forces, scarcer natural resources, and an ever-increasing demand for electricity are some of the drivers responsible for such unprecedented change. Against this background of rapid evolution, the expansion programs of many utilities are being thwarted by a variety of well-founded, environment, land-use, and regulatory pressures that prevent the licensing and building of new transmission lines and electricity generating plants. The ability of the transmission system to transmit power becomes impaired by one or more of the following steady state and dynamic limitations: (a) angular stability, (b) voltage magnitude, (c) thermal limits, (d) transient stability, and (e) dynamic stability. These limits define the maximum electrical power to be transmitted without causing damage to transmission lines and electrical devices. In principle, limitations on power transfer can always be relieved by the addition of new transmission lines and generation facilities. Alternatively, flexible alternating current transmission system (FACTS) controllers can enable the same objectives to be met with no major alterations to power system layout. FACTS are alternating current transmission systems incorporating power electronic-based and other static controllers to enhance controllability and increase power transfer capability. The FACTS concept is based on the substantial incorporation of power electronic devices and methods into the high-voltage side of the network, to make it electronically controllable. FACTS controllers aim at increasing the control of power flows in the high-voltage side of the network during both steady state and transient conditions. The concept of FACTS as a total network control philosophy was introduced in 1988 by Dr. N. Hingorani . Owing to many economical and technical benefits it promised, FACTS received the support of electrical equipment manufacturers, utilities, and research organizations around the world. This interest has led to significant technological developments of FACTS controllers

OBJECTIVES OF FACTS CONTROLLERS

The main objectives of FACTS controllers are the following:

1. Regulation of power flows in prescribed transmission routes as per controlled conditions.

2. Secure loading of transmission lines nearer to their thermal limits.

3. Prevention of cascading outages by contributing to emergency control.

4. Damping of oscillations that can threaten security or limit the usable line capacity. The implementation of the above objectives requires the development of high power compensators and controllers. The technology needed for this is high power electronics with real time operating control. The realization of such an overall system optimization control can be considered as an additional objective of FACTS controllers.

FACTS CONCEPT

Present power systems have a high rate of complexity and there is expansion in power transmission networks due to the increase in generation and loads and also due to extensive interconnections due among various power utilities. The present AC poses following challenges: a) According to the reactance of transmission lines power flow in parallel paths is determined. b) Stability considerations limit power flow in AC lines. c) Normal power flow in a line is kept much below the peak value which itself is limited by stability. d) In order to maintain satisfactory profile under varying load conditions and transient disturbances, dynamic reactive power control is required. e) Higher in load levels result in higher reactive power consumption in the line reactance. Voltage instability and collapse are expected due to mismatch of reactive power balance in the system. FACTS technology is an arrangement of high power electronic controllers, which can be applied individually or in coordination with others to control one or more of the interrelated system parameters in order to address these challenges.

Thyristor Controlled Series Capacitor (TCSC):

TCSC is a capacitive reactance compensator, which consists of a series capacitor bank shunted by a thyristor controlled reactor in order to provide a smoothly variable series capacitive reactance.

Large interconnected electrical systems it increases damping.

High speed switching capability of TCSCs provides a mechanism for controlling line power flow.

Regulation of steady-state power flow within its rating limits can be done by the TCSC.

Types of FACT controllers

(a)Series Controllers: Variable impedance such as capacitor, reactor etc., or power electronics based variable source of main frequency, sub-synchronous frequency and harmonic frequency or any combination of these can be used as a series controller. The basic principle of series controller is to inject voltage in series with the line. If the injected voltage is in phase with line current, real power is not consumed or supplied.

1)Static Synchronous Series Compensator (SSSC): A static synchronous generator operated without an external electric energy source as a series compensator whose output voltage is in quadrature with, and controllable independently of, the line current for the purpose of increasing or decreasing the overall reactive voltage drop across the line and thereby controlling the transmitted electric power. The SSSC may include transiently rated energy storage or energy absorbing devices to enhance the dynamic behaviour of the power system by additional temporary real power compensation, to increase or decrease momentarily, the overall real (resistive) voltage drop across the line.

2) Thyristor Controlled Series Capacitor (TCSC): A capacitive reactance compensator which consists of a series capacitor bank shunted by a thyristor-controlled reactor in order to provide a smoothly variable series capacitive reactance.

Advantages of the TCSC

* Continuous control of the transmission-line series- compensation level.
* Dynamic control of power flow in selected transmission lines within the network to enable optimal power-flow conditions and prevent the loop flow of power.
* Suppression of sub synchronous oscillations.
* Decreasing dc-offset voltages.
* Enhanced level of protection for series capacitors.
* Voltage support.
* Reduction of the short-circuit current. During events of high short-circuit current, the TCSC can switch from the controllable-capacitance to the controllable-inductance mode, thereby restricting the short-circuit currents

Application

* Power Flow Control
* Series Compensation
* Voltage Regulation of Long Transmission System
* Voltage Stability Enhancement
* Regulation of steady-state power flow within its rating limit.
* ENHANCEMENT OF SYSTEM DAMPING
* Voltage Collapse Prevention

Future scope

The present controller is suitable only in capacitive mode. The system studied does not include exciter, governor and voltage regulator. if compensation level is changed or if the system fault is different type then TCSC controller designed need to be changed accordingly.

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