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Utilizing SVC for transient stability enhancement

This paper describes the impact of Static Var Compensator (SVC) on the transient stability of power transmission. For demonstration of the impact of the SVC we used a 14 node test network with the fault of the branch. SVC can help to better course of the transient phenomenon ongoing in the power system (PS)

Keywords: FACTS, SVC, transient stability.

I. SVC

Static VAr Compensator (SVC) is a shunt connected static var generator or absorber whose output is adjusted to exchange capacitive or inductive current so as to maintain or control specific parameters of the electrical power system (typically bus voltage). This is a general term for a Thyristor Controlled Reactor (TCR) or Thyristor Switched Reactor (TSR) and Thyristor Switched Capacitor (TSC) [1, 2].

The term, "SVC" has been used for shunt connected compensators, which are based on thyristors without gate turn-off capability. It includes separate equipment for leading and lagging vars; the thyristor –controlled or thyristor – switched reactor for absorbing reactive power and thyristor – switched capacitor for supplying the reactive power [1, 2].

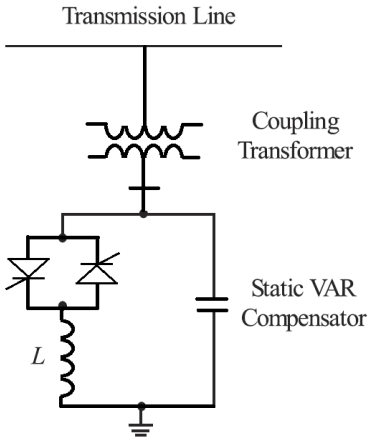

Fig. 1 SVC [1].

Basic types of SVC

Thyristor controlled reactor and fixed capacitor, TCR / FC

A reactor and thyristor valve are incorporated in each single-phase branch. Power is changed by controlling the current through the reactor via the thyristor valve. The on-state interval is controlled by delaying triggering of the thyristor valve relative to the natural zero current crossing. A thyristor controlled reactor (TCR) is used in combination with a fixed capacitor (FC) when reactive power generation or alternatively, absorption and generation is required. This is often the optimum solution for sub-transmission and distribution [4].

TCR/FCs are characterized by

- Continuous control
- No transients
- Elimination of harmonics by tuning the FCs as filters
- Compact design [4].

Thyristor switched capacitor, TSC

A shunt capacitor bank is divided into an appropriate number of branches. Each branch is individually switched on or off via a thyristor valve. Switching takes place when the voltage across the thyristor valve is zero, making it virtually transient-free. Disconnection is effected by suppressing the firing pulses to the thyristors which will be blocked when the current reaches zero.
TSC are characterized by

- Stepped control
- No transients
- No harmonics
- Low losses
- Redundancy and flexibility [4].

Thyristor controlled reactor / Thyristor switched capacitor, TCR / TSC

A combined TCR and TSC is the optimum solution in many cases. With a TCR/TSC compensator, continuously variable reactive power is obtained across the entire control range
plus full control of both the inductive and the capacitive parts of the compensator. The principal benefit is optimum performance during major disturbances in the power system, such as line faults and load rejections [4].

TCR/TSC combinations are characterized by

- Continuous control
- No transients
- Elimination of harmonics via filters or TSR

(thyristor switched reactor) control

- Low losses
- Redundancy
- Flexible control and operation [4].

II. USED SVC

For demonstrations of impact SVC on transient stability we used simulating program NEPLAN.

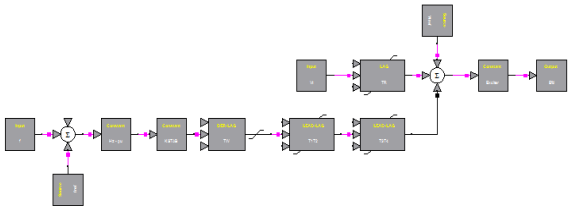

Fig. 2 AVR

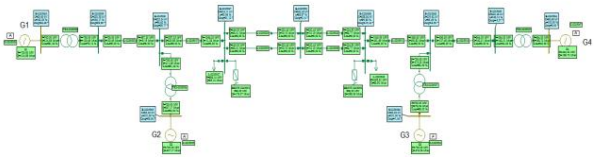

Fig. 3 Test network with 4 generators without SVC

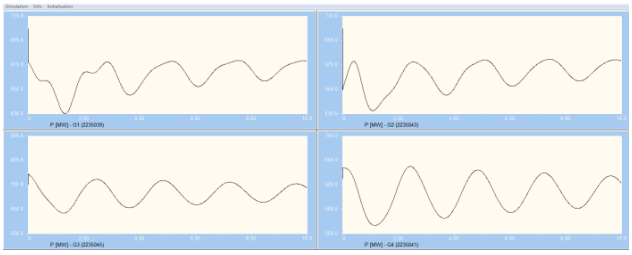

Fig. 4 Real power (MW) swings of the generators without SVC

Fig. 4 describe that the real power (MW) of the generators become to swings and the settling time of the fluctuations are very long. The long settling time adversely affect the stability of the power system, because another failure could lead to the fault of one or more generators.

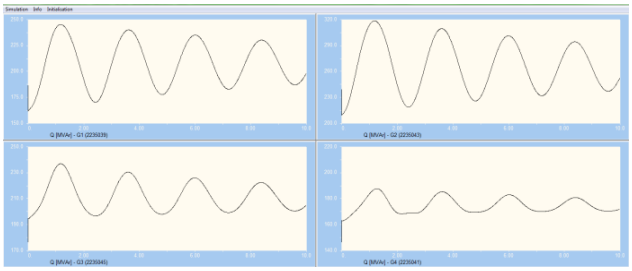

Fig. 5 Swing of the reactive power (MVAr) of the generators without SVC

Fault of the branch indicate the swings of the reactive power of the generators. This impact to the voltage of the system. Long and big swing of reactive power leads to a voltage instability.

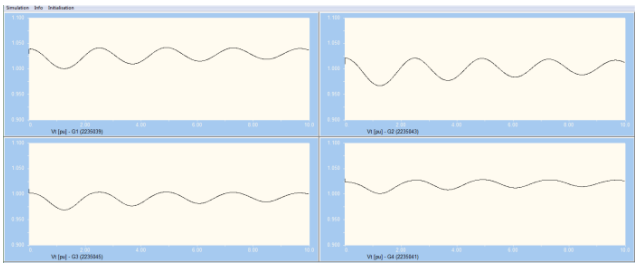

Fig. 6 Swing on the terminal voltage of the generators without SVC

Fig. 9 shows the fluctuations of the generators terminal voltage. These fluctuations indicate flicker. This phenomenon being referred to can be defined as a fluctuation in system voltage that can result in observable changes (flickering) in light output.

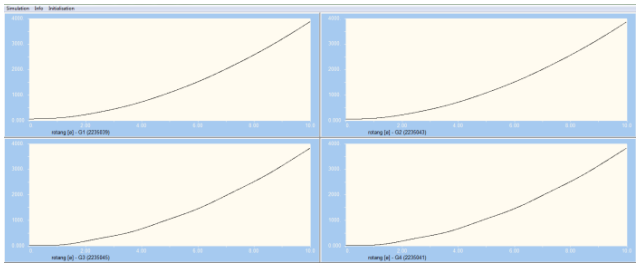

Fig. 7 Generators rotor angle without SVC

Fig. 7 shows that the generators rotor angle is changed with the fault of the branch. The critical angle for synchronous machines is 90° degree. If the generator rotor angle crosses this line, it would lose the sync.

For the eliminating of this phenomenon's, it will use a FACTS device, which main assignment in this paper is to increasing transient stability of power transmission.

As first FACTS device been used SVC.

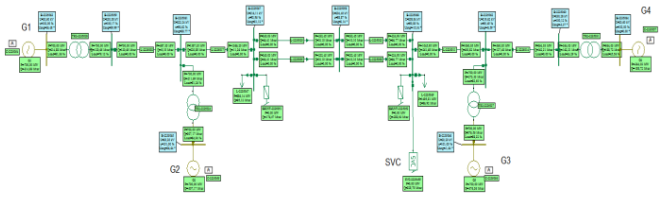

Fig. 8 Test network with SVC

SVC is connected to the node with the largest load. In this network comes to the same fault than without SVC.

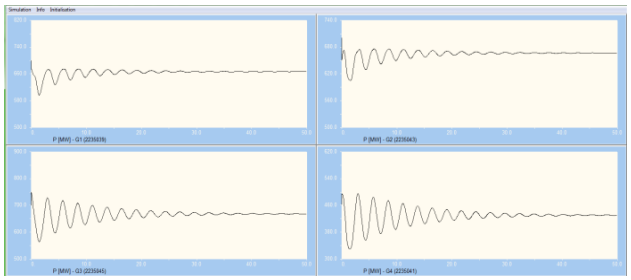

Fig. 9 Real power swings with SVC

The real power swings with installed SVC is markedly reduced than without SVC. The settling time is shorter, and the size of the fluctuations is reduced. That helps to a better keeping of the power system stability.

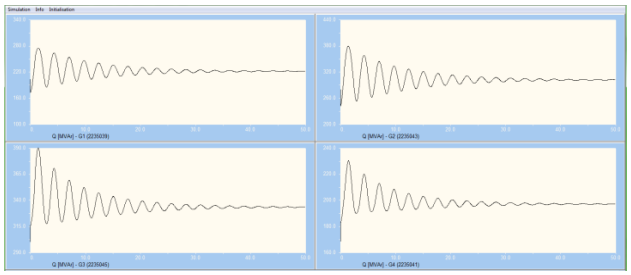

Fig. 10 Reactive power swing with SVC

SVC helps to reducing the reactive power swings too. This helps to increase voltage stability.

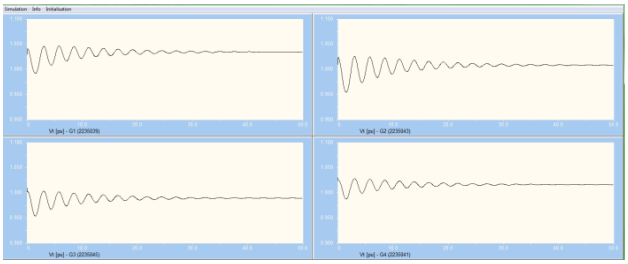

Fig. 11 Terminal voltage of the generators with SVC

Smaller swings of the reactive power indicate smaller voltage fluctuations. So it says that the flicker phenomenon is markedly reduced. For better reducing of the flicker phenomenon we can use a SVC - light that's been surveyed for eliminating flicker.

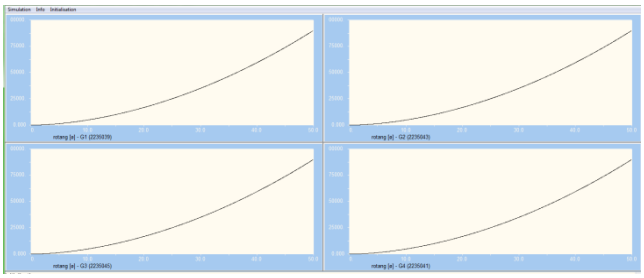

Fig. 12 Generators rotor angle with SVC

The generators rotor angle is little to change his size. This reflects the fact that SVC has not significant impact on the stability of the generators angle.

III. CONCLUSION

In this times, when the number of the non-predicable renewable energy sources constantly grown we need to increase the transient stability of power transmission. This is one of the main things what we must to do, if we want to prevent big collapses or the worst scenario and that is black out. One way for reach better stability is utilizing of FACTS devices.

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