Unbalanced Control Strategy for A Thyristor-Controlled LC-Coupling Hybrid Active Power Filter in Three-Phase Three-Wire Systems

Introduction:

When unbalanced nonlinear inductive loads are connected to the three-phase utility distribution system, a number of current quality problems, such as low power factor (PF), harmonic pollution, and unbalanced currents will rise.

If compensation is not provided to the distribution power system, it will cause a series of undesirable consequences, such as additional heating and loss in the stator windings, damage on the overloaded phase power cable, reduction of transmission capability, increase in transmission loss, etc. Implementation of power filters is one of the solutions for power quality problems. In the early days, thyristor-based STATIC VAR COMPENSATORS (SVCS) are used.

It can inject or absorb reactive power according to different loading situations. However, SVCS have many inherent problems including resonance problem, slow response, lack of harmonic compensation ability, and self-harmonic generation.

Existing System:

Instantaneous $pq$ control method in order to eliminate the reactive power, harmonic power, and unbalanced power of the loading instantaneously. In order to adapt instantaneous $pq$ control method under different voltage conditions (distorted, unbalanced,
etc), many other control techniques were further developed, such as dq control method, pqr control method, lyapunov function-based control method, etc.

However, those Instantaneous power control methods are dedicated to inverter/converter-based structures and their corresponding performances are highly dependent on the computation speed and the switching frequency of the digital controllers and the switching devices. On the other hand, another popular control method for APFS and HAPFS is to balance the system by compensating the negative- and zero-sequence current components under unbalanced loading situation, as the oscillating power/voltages/currents can be analytically expressed as Positive-, negative-, and zero-sequence components (+, −, and 0 sequences).

**Disadvantages:**
- computation steps increase a lot,
- Significantly increasing the control complexity.

**Proposed system:**

A control strategy for a three phase three-wire thyristor-controlled \( LC \)-coupling hybrid active power filter (TCLC-HAPF), which can balance active power and compensate reactive power and harmonic currents under unbalanced loading. Compared with TCLC-HAPF with conventional control strategy, active power filters and hybrid active power filters which either fail to perform satisfactory compensation or require high-rating active inverter part for unbalanced compensation, a control strategy was proposed for TCLC-HAPF to operate with a small rating active inverter part for a variety of loads with satisfactory performance.
The control idea is to provide different firing angles for each phase of the thyristor-controlled LC-coupling part (TCLC) to balance active power and compensate reactive power, while the active inverter part aims to compensate harmonic currents. First, the required different TCLC impedances are deduced. Then, independent firing angles referenced to the phase angle of voltage across TCLC are calculated.

**Advantages:**
- Controlled to balance active power and compensate reactive power,
- While the active inverter part aims to compensate harmonic currents.

**Applications:**
- Reactive power Applications.,
- Hybrid active powers filter Applications.
Block diagram:

AC source → Thyristor controlled LC coupling Hybrid Active Power Filter → Load

12VDC → Gate driver circuit

5VDC → Buffer circuit

Active inverter

PIC controller circuit