Chapter 6

Conclusion

6.1 General

This thesis has addressed the operation of 12 pulse converter operating under asymmetrical firing angle mode to achieve the constant active and reactive power operation in any industry. In industry, many power electronics equipments are operated at a time and due to that there is a continues variation in VAR demand from the supply. The main aim of operating 12 pulse converter in asymmetrical mode is to keep such demand at some constant level without changing the active power demanded by 12 pulse converter. The main contribution of the thesis includes the development of

(1) To find the region of operation and combination of firing angle to achieve constant active or constant reactive power operation.

(2) The operating range of firing angle is greatly depends on the source impedance. The effect of source impedance is discussed in detail and from that operating area is analysed to operate the converter under asymmetrical mode.

(3) Unequal firing angle generates the supply current harmonics which is required to be analysed and proper passive and active filter is incorporated.

(4) 12 pulse converter is finally analysed with Hybrid series active filter and also with combined hybrid series active filter to reduce the supply current harmonics.

The objective of this concluding chapter is to highlight the main finding of the work carried out in this thesis and provide suggestions for future research work in this area.

6.2 Summary of important findings

Chaper 2 has been devoted for the investigation of active/reactive power and harmonics in 12 pulse converter operating under equal and unequal firing angle mode. The performance of the 12-pulse converter under for the constant reactive power and the constant active power has been investigated. The variation of the active power and reactive power under equal and unequal firing angle has been calculated. For equal firing angle, the harmonic profile of the converter is found to be $12n \pm 1$. Because of the unequal firing angle, the harmonic profile of the converter is found to be $6n \pm 1$. The variation of magnitude of lower order harmonics like 5^{th}, 7^{th}, 11^{th} and 13^{th} with variation of converters firing angle is carried out. The effect of source inductance is throughly analysed and variation in operating area due to source impedance is carried out for constant active and constant reactive power is defined for per unit value. This is most important factor to achieve the aim of constant reactive power operation in any industry. Negligence of source inductance can change the results required. The 3-D Profile of variation of active power and reactive power with variation of firing angles of converter gives now clear idea for the operating range of combinations of firing angles.

The another important part of the thesis has been discussed in chapter 3. After investigation of harmonics pattern and active and reactive power in chapter 2, the mitigation of harmonics is important. After investigating the Harmonic pattern and the magnitude of the individual harmonics in the 12-pulse converter when operating under unequal firing angle mode for constant reactive power operation as well as for constant active power operation, a passive filter is designed by considering the idealistic condition of 0.5 p.u. var. The value of Inductor, Capacitor and resistor is selected. The performance of the converter is also simulated with passive filter and compared with without filter for THD, individual lower order harmonics and Active/Reactive power supplied by the passive filter. The different combination of the firing angle is found for which the converter can be operated for constant active and reactive power. The limitation of passive filter has been studied and results have been analysed. The reduction in the supply current harmonics has been achieved. The contribution of reactive power is achieved while active power remains unaltered.

The reduction of harmonics has been deeply discussed and achieved is discussed in chapter 4. The 12 pulse converter is analysed with Hybrid series active filter and significant reduction in %THD is achieved for supply current. The hybrid series active filter is simulated for a 12-pulse converter using a SRF based control algorithm as well as P-Q theory. The harmonic profile for the total harmonic distortion and the individual lower harmonic like 5^{th}, 7^{th}, 11^{th} and 13^{th} harmonic is carried out. The THD with hybrid active filter, with only passive filter and without any filter for 12-pulse converter working under unequal firing angle mode is compared and it shows that the supply current THD is within the limit specified as a IEEE 519 standard. After that the combined hybrid series active filter is simulated and results for a supply current THD, and supply voltage THD is compared with the hybrid active filter and significance effect of the combined active filter is found.

Chapter 5 deals with the experimental set up of 12 pulse converter and hybrid active filter. The 12 pulse converter is implemented using two six pulse converter and stat-star and star-delta transformer. The converter is operated for each bridge individually as a six pulse converter for different firing angle and then as a 12 pulse converter for equal and unequal firing angle to achieve constant active and reactive power. The Hybrid active filter is incorporated. The P-Q theory is incorporated using DSP processor to generate gating signal for three phase inverter . The input current waveform, the gating signals, the input and out waveform of the signal conditioning circuit is mentioned .

6.3 Scope for future work

The hybrid series active power with multipulse converter can be implemented in industry for controlling VAR requirement. The Combined Hybrid active power filter can be designed and implemented.

In stead of controlling the converter 1 and converter 2 firing angle manually, an closed loop system can be developed by just setting of required active or reactive power and firing angle can be decided by the system itself.