Analysis of load compensation by ISCT Theory

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Abstract — *This Generally this paper gives brief ideas about how the facts devices are useful for the reactive power compensation and also for load compensation. Sometime the reactive power injection in to the system is necessary for the balancing purpose. Normally use of the FACTS devices for the compensation is traditional and most useful method for the compensation and power factor improvement as well as system stability. Now from this paper we get the idea about power factor improvement. The main aim for this paper is to provide load compensation to the system and improve the source side power factor. The problem of unbalance can be minimized by using the Instantaneous symmetrical component theory efficiently. The simulation results are provided in results.in this paper how the system is balanced is shown. In this paper the FACT devices used for the theory. Instantaneous values are considered for the further process. In this paper three phase FCTCR is modelled and simulated by using MATLAB software. Simulation results give the performance and control of the FACT devices used for the theory.*

Keywords - *Compensation, Symmetrical Component, Simulink, FACTS Devices, Reactive power*

Introduction

In day today life the importance of the FACTS devices are increasing for solving power quality issues.one of them the unbalancing of the phase or system is issue that causes power quality reduces and hence directly effect on system and costing. Generally it is not possible that the transmission system is subjected to the balancing condition it may be varying i.e. might be unbalanced. So balancing the load we are going to use Instantaneous symmetrical component theory with the collaboration of the FACT device. The FACT device we are going to use is FC-TCR. That can be provide sufficient power during the need. The working of the FC-TCR is depend on the feedback received from the ISCT theory. The basic idea of the Symmetrical component is to resolve the unbalanced system into the balanced system which is equivalent to balanced system. Unbalance causes several effects on the system like heating of devices, malfunctioning of the devices as well as injection of the harmonics [10]. Hence it is necessary to balance the system. This paper proposes the balancing the load by using instantaneous symmetrical component theory efficiently. There are different types of the FACTS devices for compensation can be used. For controlling the FC-TCR there are many control algorithms one of them we are using for this simulation.

I. Fixed Capacitor Thyristor Controlled Reactor

Power Electronic devices integrating with FACTs devices are added to the transmission and distribution improves system stability [2].Generally FC-TCR is most commonly used FACT device for the compensation purpose. In general FC-TCR is combination of the fixed capacitor and Thyristor controlled reactor. As per construction fixed capacitor is placed in shunt with the Thyristor controlled reactor. Now a day FC-TCR is used in industry for the purpose of power factor correction and improving the terminal voltages of the system of the nonlinear as well as unbalanced load. FC-TCR is the type of static compensator. The complete working of this device is mainly depends on two factor 1.Impedence of the load 2. Firing angle of the load thyristor. But the main adverse effect of this system is that it is not possible to change the firing angle of thyristor every time. The working performance of FC-TCR is superior with the use of mechanical switches and synchronous condenser in the industry. The reason behind is it works transient free and precisely [1].Below shows the basic diagram of FC-TCR. fig no. 1.From the figure it is clearly seen the constructional feature of FC-TCR. Normally FC-TCR provides constant leading Var. whenever the system has lagging var due to some conditions then the leading var is provided by the fixed capacitor. Due to the provision of constant leading var in to system there is no change in the leading var. some constant value of leading Var is provided. And when system is having leading Var then this leading Var is cancelled out by the lagging Var of TCR. Hence we can say that as power our requirement we can provide leading and lagging var to the system [4].

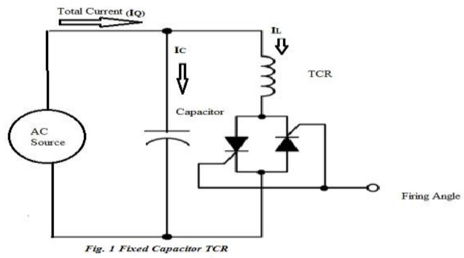

Fig 1: Fixed Capacitor TCR

II. Instantaneous Symmetrical Component Theory

The load having harmonics, low power factor and harmonics required compensation. Compensation having two type's i.e. reactive power compensation and load compensation. These loads are arc and induction furnaces, Adjustable speed drives, power electronics based loads, large motors with frequent start and stop etc. Instantaneous Symmetrical component theory is most traditional theory used for the balancing the load as well as the compensation of voltage and current and hence indirectly improving the power factor. This technique is invented by Fortescue. By using this theory we can resolve the unbalanced three phase voltage and current into balanced system. Here the three phase unbalanced nonlinear system is considered for the simulation. This working is done by cancelling the current from both devices. Load compensation by ISCT can be explained by considering the one system having unbalanced load.

This theory can be applied for both three phase three wire as well as three phase four wire system. the main purpose of this theory is to make source current balanced [5].by applying this theory load compensation can be done efficiently. The main aim of this theory is to supply balanced current in the system. The important part of this theory is to extract the positive and negative sequence current from the given supplied voltage and current and this can be done by ISCT. Generally FC-TCR is connected parallel with load. According to this theory zero, positive and negative sequence currents are added then the addition will be zero. Voltage and current can be resolved in to positive negative and zero sequence by using below matrix. This matrix can transform the respective voltage and current in to desired quantities. Required transformation matrix is

$$A=\begin{bmatrix}1 & 1 & 1\\ 1 & a & a^2\\ 1 & a^2 & a\end{bmatrix}$$

$$\begin{bmatrix}V0\\ V1\\ V2\end{bmatrix} = \frac{1}{3}\begin{bmatrix}1 & 1 & 1\\ 1 & a & a^2\\ 1 & a^2 & a\end{bmatrix}*\begin{bmatrix}Vsa\\ Vsb\\ Vsc\end{bmatrix} \text{ and } \begin{bmatrix}I0\\ I1\\ I2\end{bmatrix} = \frac{1}{3}\begin{bmatrix}1 & 1 & 1\\ 1 & a & a^2\\ 1 & a^2 & a\end{bmatrix}*\begin{bmatrix}Isa\\ Isb\\ Isc\end{bmatrix}$$

Now the reference current can be generated by using equations

$$if^*ab + if^*bc + if^*ac = il_{ab} + il_{bc} + il_{ac} \quad \text{……..(1)}$$

So finally by the calculations of the instantaneous theory we can generate reference current to the Clarke transformation block. These currents are

$$if^*ab = il_{ab} - \frac{Vs_{ab}}{V^2sab+V^2sbc+V^2sca}plavg\ldots \quad (2)$$

$$if^*bc = il_{bc} - \frac{Vs_{bc}}{V^2sab+V^2sbc+V^2sca}plavg \quad \text{….(3)}$$

$$if^*ca = il_{ca} - \frac{Vs_{ca}}{V^2sab+V^2sbc+V^2sca}plavg\ldots \quad \text{………….(4)}$$

So by using this equation we get the positive and negative currents. Now this current is provided to Clarke transformation to convert into equivalent of three phase. The reference current having 120 ° phase shift Below shows basic block diagram for the ISCT for current generation

III. Simulation and Results

Here in simulation we used star connectd load with different rating of R and L to creating unbalancing, tcr with some rating of reactive power and fixed capacitor bank connected system.by using the instanteneous symmetrical component theory we get positive ,negative and zero sequence current in form of balanced equation.now by using tcr we are injecting some current which are 120 degree apart from each other. And hence we can wet source power factor near about unity and source current balanced. Here by using the FC-TCR we are injecting some balncing current which are balance the unbalanced source current and hence power factor. Here we are injecting some reactive poweralso to compensate load.Format of load is star connected unbalaced.Objective of the compensation is to provide balanced source current in to the system and hence power factor. The simulation is carried out by the Matlab/Simulink.

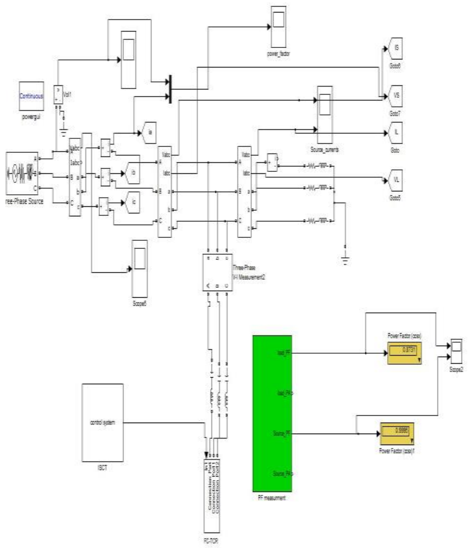

Fig 2: Main System

Generally in this system FC-TCR is connected between the load and source for provision of balanced current. In susbstem of simulation consist of Instanteneous Symmetrical Component theory with clarke transformation. By using ISCT positive, Negative and Zero sequence currents are generated. While generating these current phase delay has been provided of 0.66 and 1.32 respectively.the current obtained from these circuite is having delay of 120 degree. For generation of three pahse sequence curent we used the clarke transformation amd dqo transformation.by using dqo block from simulink we generated three phase sequence current. For generation of swiching to tcr magnitude of three phase balanced current is compared with repeatating sequence. After comparasion programme is written in to the matlab function block for switching of respective thyristor. Thristor is switched ON at current zero position. In FC-TCR thyristors are switched alternatively. SVPWM technique is used for the generating pulses for the thyristor.The programme written in this matlab function block is in form of if else.hence the total current received is balanced and hence make sourece current balanced. This is whole working of simualted model.

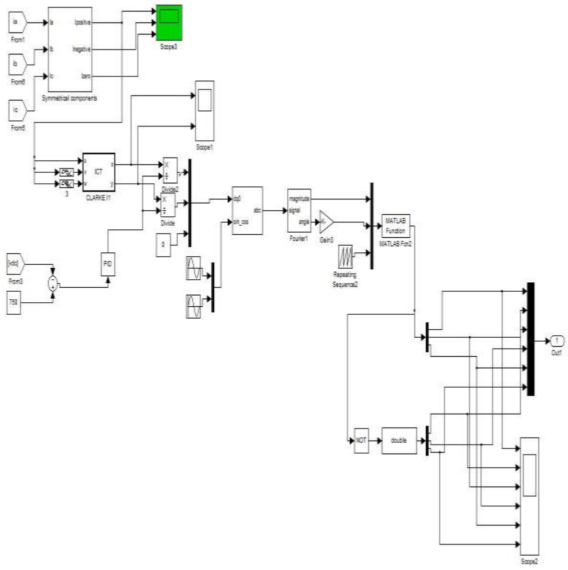

Fig 3:Subsytem

IV. Simulation Results

Simulation is carreid out for 230 V,50Hz and unbalanced load.below shows the waveform for the source current before compensation and after compensation.the value of TCR should be greater than the fixed capacitor.

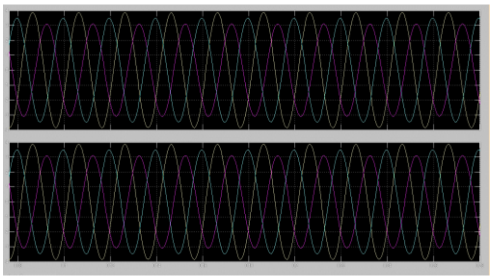

Fig.4.1 Source current before compensation

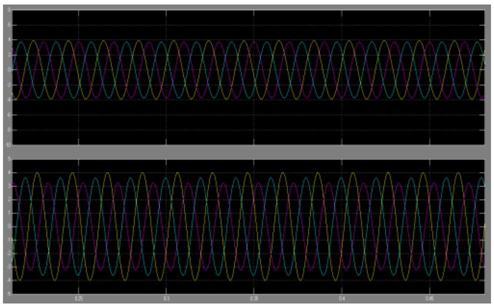

Fig.4.2 Source current after compensation

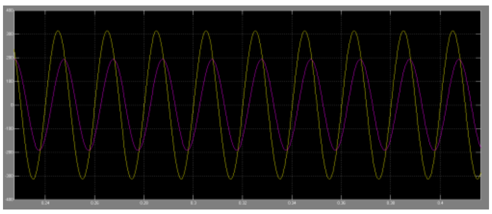

Fig.4.3 Power factor before compensation

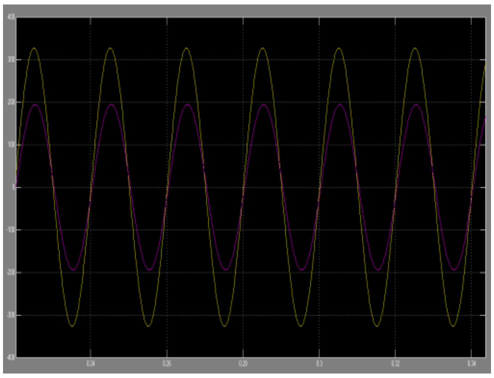

Fig.4.4 Power factor after compensation

V. Conclusion

Hence from the results we can say that power factor can be improved by using ISCT with FC-TCR. The power factor before compensation is 0.83 but after compensation power factor is improved up to 0.998 i.e. near about unity. Similarly we can say that the source current which is unbalanced in nature becomes balanced. Also the switching technique provided is works efficiently. The source current at the starting is unbalanced and causes system unbalanced. There will be no change in load current is seen in graphs. Load current will be same after or before compensation. Also the magnitude of source current becomes same.

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