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A Study of Various Traction Transformers & Active Power Compensator in Co-Phase Traction Systems

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Abstract

In this paper different type of traction transformer from the transformer family is considered in the traction system. Mainly in traction power supply systems of electric railway have many issues like voltage unbalance, high active and reactive power, harmonics, etc. This problem can be solved by implementing a co phase system with a suitable traction transformer. The traction transformers that are discussed are YNvd transformer, Impedance matching transformer and Leblanc transformer. So different traction transformers are modelled and analysed using MATLAB. In this paper Active power compensator is also modelled and discussed. The simulation results of co phase traction system using different type of traction transformer are compared for better performance. Modelling and simulation is done using MATLAB R20010a software.

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*Keywords:*Electric railway; Power Quality; Traction transformer; Harmonics;

1. Introduction

According to Present Scenario the one of the most efficient transportation system is traction system. In the history of railway first railway locomotive was designed by John Blenkinshop in 1811 and it was a steam locomotive. After that in the year 1838 many experiment were started on electric railway and in 1881 for first time electric fed trains was introduced. In 1896 in the history of traction for the first time three phase supply and induction motor were used. The basic structure of traction system is shown in Fig.1.

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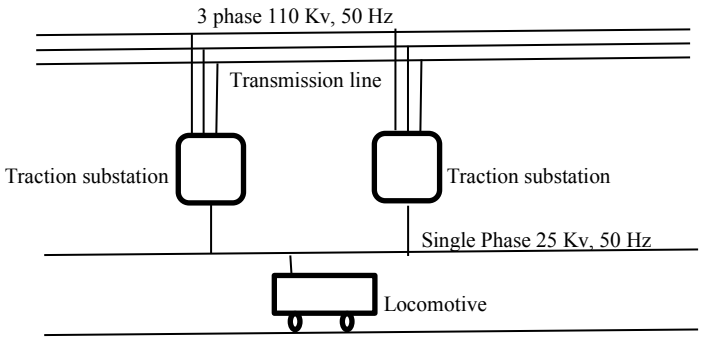

Fig. 1 Traction systems

The locomotives used in the traction systems are single phase load and are very rich in harmonics [1]. An ac traction system is fed with a supply of 25kV, 50Hz from three phase grid. Grid supply 132/110kV to electric substation (ESS) where it is step down to the required voltage [2]. In India 25kV traction system are used mostly as it is economical. Single phase 25kV, 50Hz supply is fed to the traction system from the ESS through contact wires which are generally 40 to 50km apart where it is step down from 132/110kV input [3]. Through pantograph which is fitted at the top of the locomotive, the 25kV supply is fed to the locomotive. 25kV supply is fed to the traction transformer which is present in the locomotive and it step down the voltage to 1000-1500V and supply to the motors depending on the requirement.

1.1. Power Quality Issues

In electric railways single phase loads are used. Poor quality in the electric traction systems is the result of single phase load. Few power quality issues are listed below [4]:

- Negative sequence current in the three phase grid
- Consumption of high reactive power
- Harmonics
- Voltage unbalance

Power quality deformation can be defined as a set of disturbance/condition which is caused due to unwanted result for equipment .Power quality deformation is the issue which is caused mainly due to the increase in railway locomotive. Power quality deformations directly affect the three phase grid system. These issues are getting important due to the fast growing development in the field of high speed and heavy loading railway. Nowadays, PWM converters are mostly used in the railway locomotive due to which there is a decrease in the reactive power deformation and harmonics but due to the use of PWM converter voltage unbalance has become a prominent issue. So to increase the quality of the power proper traction transformers are designed

For active, reactive power compensation active filters are used and to compensate the harmonics distortion, harmonic filters are used. In traction systems co-phase traction system were used so as to remove the disadvantage of two phase power supply system. Researchers are going on to reduce the power loss by using Hybrid Railway Power Conditioning Circuit (HRPC) using an LC branch [2].

1.2. Co-phase traction systems

To overcome the issue of two phase system, between two traction substation power is transferred by distribution line in same phase.Fig.2 shows the diagram of a co-phase traction system. Co-phase system increases the efficiency of the traction system and also reduces the cost. Another important power quality problem in the traction system is