THE EFFECT ANALYSIS OF MAGLEV ON THE VOLTAGE OF POWER SYSTEM

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Abstract As a special load in the power system, high-speed Maglev has an obvious impact on the power system. The effect of Maglev on the node voltage is studied and a new model is presented. Compared with traditional models, this model can be used to analyze the effect of Maglev on voltage more accurately. This paper will further the study about the Maglev impact on the power system..

1 Introduction

With the development of the technique of high-speed Maglev, Maglev is becoming more and more practicably. Besides its own development, the corporation with other subjects should be studied to make them develop in phase.

There are some power conversion equipments in the power system, effects are usually overshadowed by those of the concentrated loads. Industrial facilities are also more energy-intensive, which implies that the service capacity is also large, and loads such as dc drivers or high-power AC/DC rectifiers constitute a small percentages of the total facility demand. In a maglev power supply system, however, these percentages can be dramatically higher, and it is the rationale for this discussion.

Maglev is a heavy load in the power system, and it is also a nonlinear and impactive load too, the effect on the power system must be studied thoroughly to decrease its concussion on the power system. The effect of Maglev on power system includes:

(1) The effect on load flow distributing. As a heavy load, the operation of Maglev will have influence on the load flow. If the capacity of the power system or the transmission line's transmission capacity is not large enough, the Maglev system can not get enough energy, then the quality of electric energy will decrease.

(2) The effect of impactive load on the voltage. The Maglev is an impactive load, it has an effect on the voltage of the power system, and it even lead to unstability of the power system.

(3) The effect of harmonic current. The maglev load has a convertor, as a harmonic electrical source, its impendance is larger than the system impedance, so most of the harmonic wave which is reduced by the convertor is infused to the power system. The harmonic current can cause the distortion of the line voltage and line current. There has been much concern expressed in recent years over the voltage distortion caused by power electronics based nonlinear loads on the electric power grid. When fed directly from the utility power system, these nonlinear loads generally draw nonsinusoidal harmonic currents, which can lead to significant line voltage distortion.

The use of high-power static conversion equipment has been common place for a number of decades in certain industries. However, harmonic currents are generally undesirable[4],their interaction with the ac power supply system can result in unacceptable levels of harmonic voltage distortion, overloaded phase and neutral conductors in branch distribution circuits, overheating of transformers and motors, or interference with the operation of sensitive electronic equipment. A major drawback of previous and present power conversion technologies is the generation of significant amounts of harmonic current distortion.

The impactive effect of the Maglev on the node voltage is studied in this paper.

2 The Electric Character of the Maglev Load

Maglev has such advantages as Lower power consumption, less noise, higher acceleration and deceleration rate and higher climbing capability[2].These characteristics ,together with its safety and comfort due to the absence of mechanical contact,make it more wide prospective for further development.

High-speed Maglev has high acceleration, the current curve getting from simulation shows that it is impactive load. The current curve has many remarkable pinnacles. Its impact character can be seen from Fig.1[9].

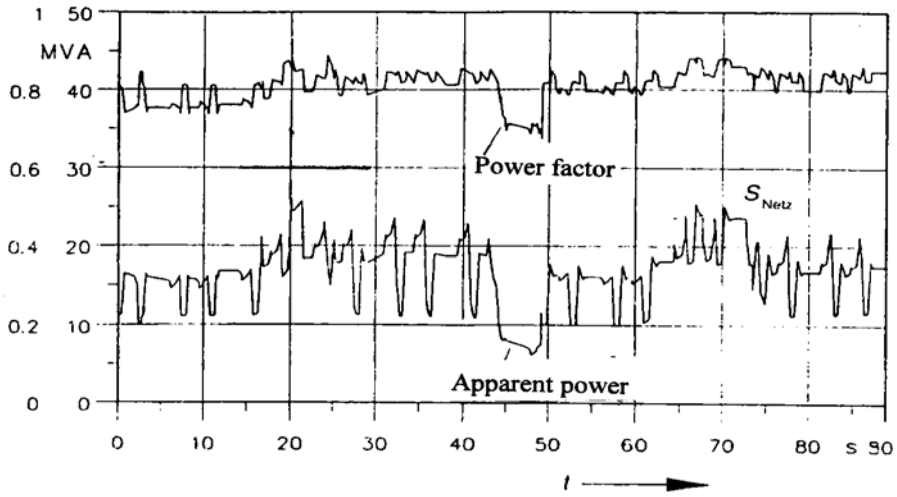

Fig1. the curve of the power factor and apparent power of Transrapid

The main energy of the Maglev load comes from the power system, its active power and reactive power are determined by the state of the maglev and its driving mode. The fluctuation of the power will arise the fluctuation of the node voltage. The measures that can be adopted includ: 1) Enchancing the grid of the power system to ensure the system stability enough. 2) Compensate facilities are installed in the Maglev system. No matter what measures been taken, it is necessary to analyze the effect of Maglev on voltage more accurately.

The Maglev is a nonlinear time-variant load and can cause a significant distortion of the line voltage and line current. Its electrical characteristic can change along with the time, in a certain conditon ,it can cause impactive current of short time, wich is called short time harmonic current.As a result, a drop of the node voltage will happen,and this seriously affect the stability of the power system sometimes.

Representation of load models plays an important role in studies of power system dynamic and transient stability. Because Maglev load is a time-variant, its characteristics can not be discriminated by one function. In this paper, we treat it as an impactive load with a variant current approximatively.

3 Principle Analysis

In the analysis of one power system, it is usual that active power and reactive power are not coupling.That is to say, active power relates to frequency, and reactive power relates to voltage respectively. In fact, when the load is an impact, there is a relation between active power and voltage.

For a middling long circuitry, its equivalence circuit can be expressed with πtype or T type circuit.π circuit is common used, as shown in fig1. we useπcircuit to express the influence of the active power on the voltage of the power system . In this figure, the arrow stands for the Maglev load.

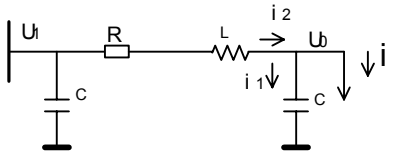

Fig.2 theπtype circuit model of the transmission line

Fig.1 shows that the load of Maglev is connected to an infinite bus through a transmission line. The voltage of the infinite bus is u_1, and the voltage of the load bus is u_0. Figure 1 can be described in the following equations:

$$\begin{cases} i_2 = i_1 + i \\ \Delta u = L\dfrac{di_2}{dt} + i_2 R \\ C\dfrac{du_0}{dt} = i_1 \\ \Delta u = u_1 - u_0 \end{cases} \quad \text{(Eq.1)}$$

From the above equation, we can get:

$$LC\frac{d^2u_0}{dt} + RC\frac{du_0}{dt} + u_0 + (L\frac{di}{dt} + iR - u_1) = 0 \quad \text{(Eq.2)}$$

We can get the expression of u_0 from the equation 2.

$$u_0 = c_1 e^{\alpha t} + c_2 e^{\beta t} - (L\frac{di}{dt} + iR - u_1), \quad \text{(Eq.3)}$$

$$\alpha = \frac{-RC + \sqrt{R^2C^2 - 4LC}}{2LC} \quad \text{(Eq.4)}$$

$$\beta = \frac{-RC - \sqrt{R^2C^2 - 4LC}}{2LC} \quad \text{(Eq.5)}$$

From Eq.3 , it can be seen that if we can get the value of $\frac{di}{dt}$, then we can get the value of the unkown u_0.

In the simulation of the Maglev, we can get the current curve. As for the Maglev is an impactive variant load, when it runs in the power system, it will bring the heavy impactive current which lasts a short time only. Theoretically, the current is not seasonal, it can not be expressed by Fuler progression,and we can not get the value of $\frac{di}{dt}$ easily. So We use the mean of the absolute value of i to substitue for i to calculate $\frac{di}{dt}$, then we can reduce the calculation burden.

Based on this model, a program can be compiled, the result of a sample system will show that the voltage of load point's decrease significantly if we don't take any countermeasure. Based on the result, we can study further what_compensate measures and compensation capacity should be used. Compared with traditional model, the new model can analyse the effect of impactive load on voltage of power system more accurately.

4 Some Measures should be Taken

Power quality problems are serious in power network. Long transmission and distribution lines that have high line impedances cause substantial voltage drops, resulting in insufficient voltage regulation and unbalanced supply voltage near the end of the line .At the same time, harmonics generated by nonlinear loads, such as adjustable speed drives, and in general, electronic power converters create additional power quality problems at the customer end.

There are many measures to reduce the effect of impactive load on voltage:

(1) Reduce the inductance of the transmission line. This can be realized by reducing the electric distance from the power system to the load or increasing the number of the transmission line;

(2) Compensate the active power at the point by Superconducting Magnetic Energy Storage.The SMES unit has received much attention in power industry, especially since the successful commissioning test of the Boneville Power administration 30 MJ unit has been reported, together with the substantial developments in the technique of high-temperature superconducting materials, and the project of building a test plant towards commercialization of this technology for utilitiy[7]. The SMES unit is designed to store electric energy in a zero-resistance superconducting magnetic coil by a D.C circulating current through the coil. The original purpose of the SMES unit was load leveling, whereby during the off-peak period, electric power is removed from the power system, and switched on during the peak period. An additional function of the SMES unit is the improvement of system stability by providing fast power modulation during dynamic periods.

(3) Some other measures using power electronic devices.

5 Conclusion

The characteristics of the high speed Maglev is explained in this paper, and the principle of the effect of Maglev on the voltage is studied. From this paper we can see that we must study electrical characteristics of Maglev and the status of the power supply system to ensure the safe operation of the power system and the Maglev system.

From the analysis above, we can see that the Maglev load has an significant effect on the power system, especially on the node voltage, we can get the conclusion as follows:

1) As a heavy impactive load, Maglev has an effect on the power system, especially on local power networks.

2) We must study the capacity of the local power system and how close it connects to the power system to find appropriate running mode of the power system,

3) Accurate calculation must be done to make it more clear how much the Maglev load will effect the power system.

4) Based on the results, some measures should be taken to reduce the effect of the Maglev load on the power system, if necessary, we should modify the power system.

5) The model in this paper can be used to calculate the effect of the Maglev on the power system more accurately.

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