Assess of the Flicker Caused by Electric Arc Furnace Using Simulation Method*

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Abstract. In order to assess the flicker caused by electric arc furnace, the simulation method to assess flicker and its application in electric arc furnace power system is studied. Firstly, based on the Flicker Meter functional and design specifications recommended by IEC, an IEC Flicker Meter is designed concretely; Secondly, an IEC Flicker Meter model is established in SIMULINK, and a special M file which can be used to calculate the short term flicker sensation indicator ($P_{st}$) is compiled, according to the IEC criterion, the Flicker Meter model is tested; Finally, assess of the flicker caused by an actual electric arc furnace is achieved, the instantaneous flicker sensation $S(t)$ in the point of common coupling is gained. The results show that application of simulation method to assess the flicker caused by electric arc furnace is an effective way.

Keywords: Electric arc furnace, voltage fluctuation and flicker, Flicker Meter, simulation.

1 Introduction

When impact load of high power connected to power grid of relatively small capacity, such as electric arc furnace, mine hoist, heavy merchant mill, heavy electric welding machine as well as electric locomotive, voltage fluctuation will be caused, which will undermine other electric equipments which are connected to the point of common connection. With the wide application of the above mentioned impact load of high power, as ref. [1], voltage fluctuation and flicker has become one of the key indicators to measure the power quality of the grid.

Electric arc furnace (EAF) is not only a major facility in steel factory but also one of the super impact loads of single capacity in the power supply system. The components of voltage fluctuation frequency due to EAF is mainly distributing in 4~14Hz band.

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which is precisely in the visually sensitive areas of human beings. Therefore, among all sorts of impact load, EAF has the most severe impact on voltage fluctuation and flicker as shown in ref. [2]. The regulations from home or abroad on voltage fluctuation and flicker limits are specific about EAF. Generally, the terms can be applied to all the other types of loads if they can meet the requirements of EAF. In order to improve or inhibit the voltage fluctuation and flicker caused by EAF, some relevant compensation facility such as SVC which is needed to be used in the power grid. Because accurate flicker values are needed for the research and setting of these devices, the accurate measurement or estimation to flicker value is the prerequisite for solving the problem of voltage fluctuation and flicker.

The flicker severity caused by EAF can be directly measured by Flicker Meter or estimated by simulation method. As shown in ref. [3-7], the research and application of Flicker Meter has been the focus of experts from home and abroad. In recent years, there are literatures (ref. [8-11]) on flicker simulation method emerged, but most of them are only focusing on the simple simulation method research. And literatures of further studies on application have been rarely involved, so they are not supposed to guide the practical application. In addition, the accurate signal of voltage fluctuations which can be obtained through simulation system is a prerequisite for the application of simulation method. The accuracy of the signal depends on the mathematical model of load characteristics. The signal can also be obtained through analysis of field measurement data. When the waveform of voltage fluctuations is recorded, waveform of any time-domain can be divided into a series of residential section of signals which are input to the flicker simulation measurement system for data processing. And finally get the results of instantaneous flicker sensation level \( S(t) \) and other short-term flicker value \( P_{st} \).

2 IEC Flicker Meter

The designing standards of the Flicker Meter recommended by IEC only provides schematic diagram and design specifications, without mention of the specific design details and design parameters. Therefore, understanding the physical sense of the input and output signals of each part in the flicker measurement system correctly and setting specific technical details in each part become the priority of the research of flicker measurement system. The schematic diagram of the Flicker Meter recommended by IEC61000-4-15 (ref. [12]) is shown in Figure 1.

In figure 1, the frame 1 is an input adapter link with fluctuant voltage signal input. It is used to reduce the input voltage of different levels to the level applying to internal circuits.

The frame 2-4 simulate of the reaction of light- eye-brain to the voltage fluctuation. Among which, frame 2 simulate the function of light, realizing square demodulation to the voltage fluctuation component and obtaining the voltage signal in linear relation with component of the voltage fluctuation.

The band-pass weighting filter part of the frame 3 is made up with a band pass filter and a visual sensitivity weighting filter in series, which reflect the sensitivity of the illuminance change of tungsten filament lamp of 60w, 230v in the voltage fluctuations