STATCOM Modeling for Mitigation of Voltage Fluctuations caused by Electric Arc Furnaces.

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***Abstract*—Voltage fluctuations caused by rapid industrial load changes have been a major concern for both power companies and customers in the area of power quality. The fast response of the Static Compensator (STATCOM) makes it an efficient solution for improving power quality in distribution systems. This paper describes a model for a PWM-based STATCOM used in a distribution system for mitigation of voltage fluctuations produced by an Electric Arc Furnace (EAF).**

The analyzed system is modeled using MATLAB/Simulink Power System Blockset (PSB), including a complete STATCOM model with its power circuits and its control system. The complete model is validated by field test.

Static and dynamic performance of STATCOM is evaluated and voltage fluctuation mitigation studies are performed and discussed. The voltage fluctuation mitigation is obtained by measurements and according to international standards.

***Index Terms*-- Arc Furnaces. Flicker. Harmonics. Power Quality. STATCOM.**

I. Introduction

Many loads connected to electric power systems may cause power quality problems at all voltage levels and for very different power ratings due to their unbalanced and non-linear behaviour characteristics. However, the main sources of power quality problems affecting large numbers of customers are the high power industrial loads. The rapid large swings in active and reactive power required by such loads cause rapid repetitive voltage variations with appreciable voltage distortion caused by harmonics and unbalance. The residential and commercial customers supplied by the same network are subjected to the impact of these voltage variations that produce disturbances to their equipment and flicker in the light output of their electric lamp.

EAF loads can result in serious electrical disturbances on a power system. Low level frequency modulation of the supply voltage of less than 0.5% can cause annoying flicker in lamps and invoke public complaints when the frequencies lie in the range of 3-10 Hz.

Some form of reactive compensation is usually required to limit the disturbances injected by EAF into the electric power system, in particular the flicker. This is usually achieved by connecting a compensator to the busbar in which the disturbing load is situated.

The most effective way to control voltage fluctuations and therefore to limit flicker is to compensate the reactive power variations of the fluctuating loads at medium/high voltage levels.

This paper presents the voltage flicker measured at a steelwork busbar, where an 8-tons, 2.5 MW EAF is connected. To mitigate the voltage fluctuation phenomenon, a 4 MVAr STATCOM was included in the steelwork busbar. The mathematical model and the control strategy to compensate voltage fluctuations are explained and described in detail. The capability of the STATCOM to mitigate voltage fluctuations is demonstrated by digital simulations and experimental results.

II. Power System Configuration

The lay-out of power system is shown in Fig. 1.

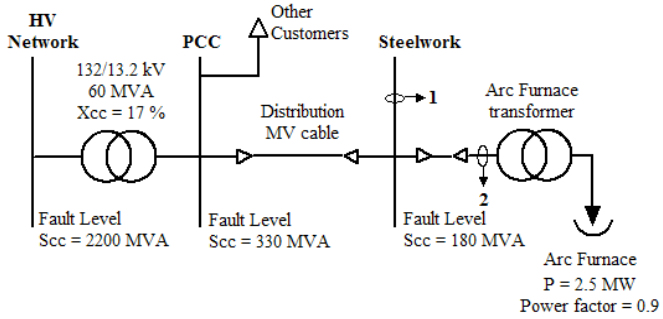

Fig. 1: Electrical system configuration.

The steelwork is supplied directly from public distribution network at 13.2 kV. Measurements of three-phase voltages and currents were taken at point 1 (steelwork supplying point) and point 2 (primary of EAF feeding transformer).

III. Characteristics Of Electric Arc Furnaces

An EAF consists of a refractory lined shell which holds the charge, usually scrap metal. Three large electrodes, usually of graphite, are held in special clamps on a swing support structure which can be swung aside for charging, and which allows each electrode to be raised or lowered according to the output of the control system.

After the furnace is charged with scrap, operation begins by lowering the electrodes to strike electric arcs between the electrodes and the scrap. The heat generated by the three electric arcs provides the heat for melting and refining the scrap.

There are several phases in the EAF operation, each presenting a different impact on the power system in terms of flicker, namely the:

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