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Improving electric power quality within the power supply system of wide-strip hot-rolling mill stand

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Abstract

The paper proposes studies of electric power quality indexes for 10 kV network supplying electric drives of the wide-strip hot-rolling mill stand equipped with thyristor electric drives. It provides the power supply diagram of the plate rolling shop. Information on the methods of experimental studies of the current and voltage spectral distribution with the use of a standard measuring device and software is provided. The paper shows the nature of higher-order harmonics content for units of the 10 kV distribution substation. It considers the method and system for reactive power control in the load center that ensures a step power change of the reactive-power compensator batteries and the following smooth fine adjustment by automatic control of synchronous motor excitation current. According to the algorithm proposed condenser batteries shall be operated in the basic mode and compensate a semi-constant component of reactive power.

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Keywords: electric network; hot-rolling mill; thyristor electric drive; spectral current distribution; measuring device; experimental researches; reactive power; compensation; control systems; algorithm.

1. Introduction

An essential condition for fault-free power supply of the industrial enterprise is a stable power consumer supply of the required amount and quality specified by national and international standards. Here, power consumers with

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non-linear current/voltage diagrams (thyristor converters used for supply of high-power DC electric drives) mainly effect electric power quality [1, 2].

Typical examples are power supply systems of the plate rolling shops where one power supply source provides electric power for quiescent loads (descaler pumps, vents, etc.) and stands of the rolling mill featuring Thyristor-Converter-Motor electric drives. That is why, voltage fluctuation and deviations may be observed within the distribution shop networks; their sources are thyristor converters [3]. Furthermore, these networks have a low power factor resulting in reactive-power shortage of the system [4]. These specific parameters of power supply are fully characteristic for the plate rolling shop No. 10 (PRS-10) at OJSC Magnitogorsk Iron and Steel Works (OAO MMK) with its major unit – the 2,000 mm hot-rolling mill.

The PRS-10 power supply system is shown in Fig. 1. The following voltages are used for supply of power equipment:

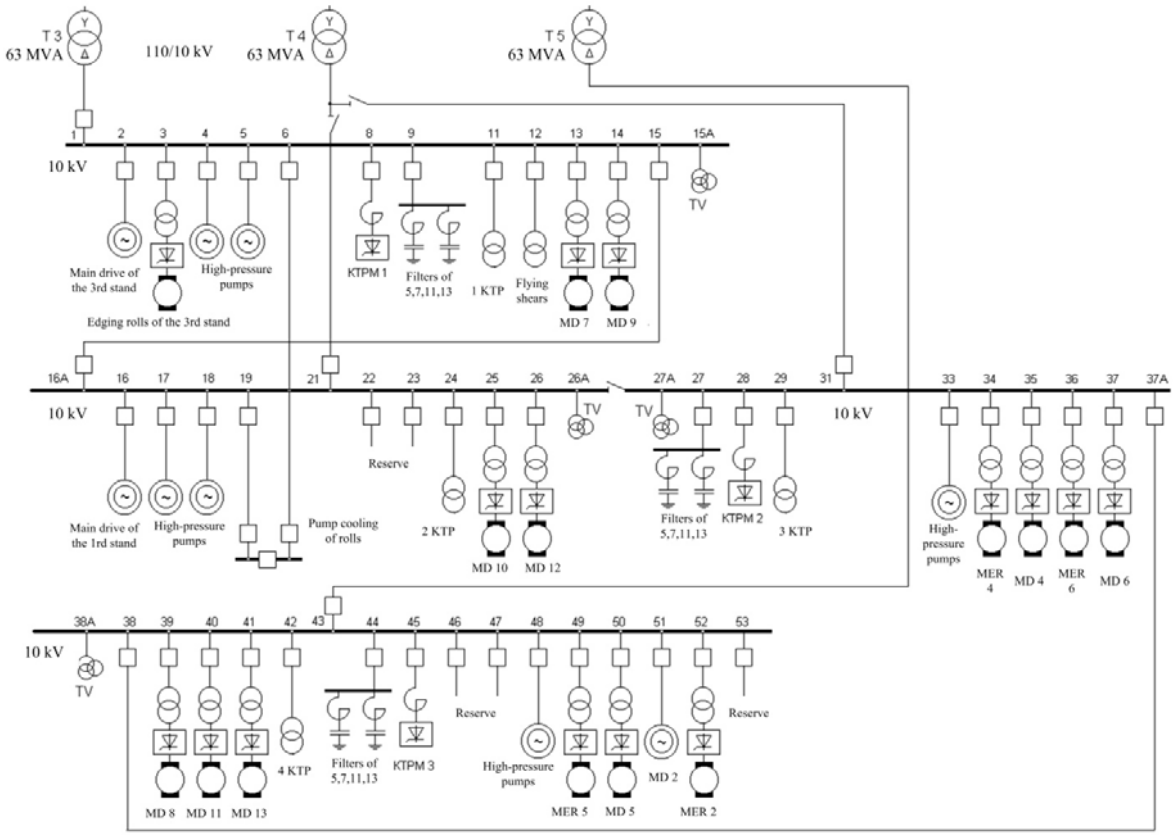

Fig. 1. Diagram of power supply for the 10 kV distribution substation (DS) of PRS-10

– 10 kV – for three synchronous motor of main electric drives of roughing stands No. 1-3, pumps for roll cooling, high-pressure pumps as well as thyristor converters of main electric drives of stands No. 4-13 and flying shears;

– 6 kV – for supply of asynchronous and synchronous 200–1600 kW motors as well as thyristor converters of auxiliary electric drives and step-down transformers of the complete transformer substations.

Total capacity of power consumers at 10 kV voltage is as follows:

– synchronous motors: 35 MW;

– thyristor electric drives: 140.6 MW;