1. INTRODUCTION

1.1 Introduction

End user experience with power quality issues has increased steadily in recent years due to ever increasing use of microprocessor controlled loads which are more sensitive to AC power supply disturbances. Along with this growth of awareness has come a corresponding increase in the responsibility placed on power utilities. As a supplier of electric power, the utility is expected to guarantee adequate power quality for the end user needs. When power problems interfere with reliable operation of business equipment, the customer first impulse may be to blame the power company for producing dirty power. The reality is that considerable percentage of power problems originate within customer’s facilities. Power quality is a growing concern for a wide range of customers. Industrial customers experience interruptions in important processes during momentary voltage sags associated with remote faults on the utility system. Commercial customers are applying high efficiency lighting and electronic office equipment, resulting in higher harmonic levels in the buildings. Even residential customers are concerned about surge protection for sensitive electronics in the home and the impact of momentary interruptions on their electronic equipment. Among other things, the vulnerability of sensitive equipment to the quality of power has been the major force behind recently initiated and mainly power utility funded research and development work on quality of electricity supply. From power quality engineers viewpoint, an electric arc furnace represents one of the most challenging candidates among industrial loads. When the arc is striking through the scraps it appears like a short circuit on the secondary side of the furnace transformer. The short circuit current keeps changing in response to the melting conditions of the furnace content (scraps).

The factors influencing power quality are as follows. Outages, Voltage drop, power factor, Transients (lightning and switching surges), non-linear steady-state load conditions. The purpose of harmonic studies is to characterize and to model harmonic generating sources. AC arc furnaces generate both integer and inter-harmonics during
their electrode striking, melting and refining stages of operation. Transformers and reactors supplying power to arc furnaces are also generating harmonics because of magnetic core saturation. The harmonics generated are dynamic and random in nature. The harmonics generated depend not only on the saturation level of the magnetic core but also on the structure and configuration of the components. Arc plants with Electric arc furnaces have converters; thyristorized drives which produce harmonics of significant nature.

With energy applied to the arc furnace position of the raw material and scrap steel is heterogeneous and will cause irregular variations in the lengths of electric arcs. This will cause the electrical energy input to vary significantly if the electrodes are kept static. Automatic and manual control is necessary to achieve effective production of steel. The arc parameters guide to take important and crucial decisions. New ideas are emerged in the investigation of electrode control system.

1.2 Necessity

There will be an increasing need for industrial and commercial end users to have electricity in high power quality. The arc furnaces used for melting and refining metals produce voltage flicker and harmonics. These are the adverse impacts introduced by arc furnaces. In order to propose solutions to minimize these adverse effects of arc furnace the impact of these highly non-linear, time-varying loads on the power quality of the overall power system should be investigated. Several studies have been done in order to build an accurate circuit model to represent the arc furnace operation which is not still available. There is a need of assessing power quality in arc plants. The work done so far in this area needs further investigation and hence new ideas are introduced which will bridge the gap to some extent.

Also it is necessary to study power quality as a holistic approach and the same is addressed in this work. Electric arc furnaces have historically been controlled by regulating the impedance of each electrode and by controlling the position of the electrodes in relationship to each other and to the charge. Recently, combining this type of control with improved power factor control has allowed plants to achieve
major cost savings. Electrode control influences arc parameters during arc operation. The determination of arc parameters by digital control has contributed to new ideas.

1.3 Objectives

In order to analyze and critically study the power quality aspects in Electrical arc plants, following objectives have been set:

- Study and explanation of power quality disturbances in arc plants.
- Investigate and analyze power quality problems
- Simulate various power quality disturbances based on practically obtained data
- Analyze practically recorded powers, voltage sag, harmonics, flicker, current and voltage distortions, events leading to new contributions.
- Develop new ideas and formulate new hypotheses
- Establish new contributions for improving power quality of electrical utility

1.4 Theme

The power quality problem has been analyzed by many aspects. It is found from practical events that many forms of disturbances emerge leading to system behavior which is not possible to forecast. Also, it is observed that working of various electrical and electronic machines is influenced by power quality disturbances.

The main theme of this work is to analyze various power quality disturbances by using computer simulations. Analysis of practically recorded data is carried out to verify effect of power quality disturbances on power system and new schemes are developed to prevent system failures due to mal-operations. The study on arc plant is done by identifying power quality aspects, influencing factors, standards and regulations, power quality indices, harmonics analysis, power quality mitigation.
Figure 1.1: Theme of Research Work

Hence, the main theme of this work is to analyze various aspects of Power Quality in Electric Arc Plants and analyze the power quality disturbances, study the effect of electrode regulation system on the behavior of arc furnace operation.

According to the objective set the research work is divided in to three categories.


These three main categories are further sub-categorized as per the area of research.

The pictorial representation of the research work is depicted in the Figure 1.1.

1.5 Methods

The methods used are as summarized:

Use of practically recorded events and data for analysis and simulations.

Development of programs in various related softwares for analysis of power quality and simulations.

Development of new ideas leading to new hypothesis.

Testing of new hypothesis against practical background.

Development of new solutions to overcome system behavior under unforeseen circumstances to maintain power quality.
1.6 Organization

This theme is organized in following independent parts with a continuous theme as per abstract:

Chapter 1: Introduction: This chapter introduces the aspects addressed by this thesis and purpose with details of odd issues addressed.

Chapter 2: Literature Review: basic concepts of power quality and literature referred are explained in depth and relevant literature is mentioned.

Chapter 3: System development: The research methodology used in the thesis work is applied leading to analysis of data and models are developed wherever necessary with particular references. Mathematical treatment is explained with relevant references.

Chapter 4: Performance Analysis: Analysis and simulations carried out are presented leading to conclusions and finally to new contributions. Computer programs are developed and using softwares like Power flow and PSCAD practically events of sag, flicker and other power quality disturbances are analyzed in detail and new concepts are developed leading to conclusions and contributions. Comparative analysis of practical events and analysis is done in the area of power quality disturbances and error is justified leading to new contribution.

Chapter 5: Conclusions, future scope are mentioned in this chapter. Contributions found during the research work are mentioned at end.