5. CONCLUSIONS

5.1 Conclusions
Electric Power Quality in Arc plants is analyzed by performing harmonic audit, developing arc furnace model and assessing power quality disturbances. The analysis of arc furnace, rolling mills and flicker mitigation by SVC is done.

1. Harmonic Analysis
3. Flicker Mitigation by SVC

Harmonic Analysis
The observations are enlisted as:

- In Arc Plants, operation of arc furnace, rolling mills and thyristorized drives produce significant harmonics. The harmonics flow through the plant and utility power system resulting in voltage distortion and power losses. They also interact with power factor correction capacitor banks leading to equipment failures. Practically, harmonic levels may cross the acceptable limits for a particular reason at particular hours of the day and/or for a typical system load pattern remain unnoticed.

- For measurement of harmonics, various sites were visited and detailed harmonic levels, plant power were noted. If output is given through harmonic analyzer, harmonic analysis is continuously available.

The results of analysis provide
- Decentralized filters can achieve better transient performance.
- Addition of new capacitor with non linear arc furnace magnified harmonics.
- Harmonics in rolling mills is high because of thyristorized drives
- Failure of surge suppressors in EAF and transformer components due to transients and momentary high stress.
- Voltage sags on one of the lines has produced voltage and current unbalances.

Thus, by minor additions in the set up, existing conditions can be explored for continuous recording and harmonics analysis and filter performance.
Furnace Performance Analysis

Circle Diagram Analysis:

- For operational set point, distribution of active power and reactive power points are on constant apparent power curve instead of constant voltage curve hypothetically, long time for scale measurements.
- Good foaming results in improved power factor, poor noise index, proportionate relationship between active power and secondary voltage; while during melting stage, this is not so.
- For fixed KVA (maximum), as tap voltage (corresponding to higher taps) increased, the refractive index, power factor and active power also increased with reduced reactive power, loss power and current of corresponding tap.
- For maximum arc power, power factor remained same while current increased corresponding to lower taps to operating range tap.
- At nominal current of tap (maximum), refractive index increased.

Electrode Control System

Histograms provide the useful information about regulation system behavior. Digital control strategy for electrode control is suggested to optimize arc parameters. The measures like change of phase timing and digital control strategy will enhance the optimization of arc furnace.

Furnace data analysis provided the results

- Minor upward regulation in severe melting is allowed considering safety.
- Close operating band for Impedance gave precise electrode control
- A good foaming slag reduced refractory wear
- Tap selection decided from arc stability and hunting
- Thermal balancing reduced electrode consumption by properly choosing tap
**Power Quality Mitigation Analysis**

The major disturbances occurring in steel plants are voltage flicker and voltage sag. The energy can be saved on large amount if corrective measures like using power quality improvement devices are used. SVC is the best option for large industries. Harmonic mitigation is accompanied by energy saving. The analysis at different sites at rolling mills in Jalna, Lloyd steel and Bhilai Steel Plant provides results.

- Shorter melt down times
- Reduced energy losses
- Reduced electrode consumption.
- Acceptably low flicker level at the Point of Common Coupling
- Acceptably low amounts of harmonic distortion
- Adequate load balancing between phases of the 132 kV grid
- A high and constant power factor at the feeding point of the plant, with low and constant reactive power consumption from the grid
- Keeping grid reinforcements at minimum

**5.2 Future scope**

Study and Analysis of Power Quality in Arc Plants is carried out in details for various power quality disturbances. Inter harmonics as one of power quality disturbance cannot be ignored. The effect inter harmonics on furnace operation rolling mills in the arc plant must be studied. There is scope for developing model of arc furnace and rolling mills considering inter harmonics. Non-electric factors should be considered for detailed analysis.

**5.3 Applications**

The study and analysis of the research will be helpful for all steel industries and plants in which power quality improvements steps are not taken. Only the energy conservation and power factor correction measures are not sufficient in the industry but power quality assessment and the corrections thereof are also important. The contributions of the research work will enable to work the plant in efficient and energy saving would be obtained if the measures are implemented.