PF Correction Techniques in highly varying load

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Issues Faced in Industries

- Modernization of Industries – Shift to Electronic Controls
- Almost all loads (which were hitherto linear) became non-linear
- To maximize PF incentives, source side PF improvement is attempted through Fixed capacitors or through APFC or slow response Thyristorized systems.

Issues Faced in Industries

- While this helps maximize PF Incentive, PF under low load, fast changing loads, unbalanced loads is found either low lagging or leading.
- Improper method of capacitor switching is seen to generate Harmonics.
- Unbalanced loading conditions are prevailing in the industry.
Issues Faced in Industries

- Equally distributed single phase loads across three phases are not necessarily a balanced load.
- When one single phase load trips, the load becomes unbalanced, calling for Unbalanced PF compensation.

Impact of varying loads on PF - various applications
Aluminum Rolling Mill application

PF/kW profile.
Hot Mill Main Drive, 2.25 MVA Tr, 3.3 kV side

Drive application

PF/kW profile
Cincinnati India Rd
Furnace application

At 2000 KVA Transformer Incomer

Mining application

PF/kW profile

Power Generation
CT Scan application

PF/kW profile
Cummins India Ltd

PF/kW profile
Oil Rig Application

Time [HH:MM]
Unbalanced PF across phases

Impact of varying load on PF
Impact of varying load on PF

Wheels India Limited
Cummins Power Consulting

Resulting PF dropping to 0.01 lag momentarily
When load changes
kVAR does not change adequately

For the same load levels, the PF profile of individual phases remain unchanged (with and without APFC) though the load is unbalanced. Average PF is leading with APFC
Other Applications

- High Rise Buildings where many lifts can operate at a time.
- Furnace Loads
- Industries where Heavy Motors are switched on simultaneously
- Industries experiencing Voltage Flickering Problem.
Effect of Capacitor switching method on harmonics

PF/THD V & I profile
Capacitance effect on harmonics

Without capacitor

With capacitor

Impact of wrong compensation on harmonics

PF vs THD I Tr 1
Tudor India Limited

With every step of APFC, PF improves and THD I increases. % THD I increased from 13.8% to 22% on application of 200 kVAR Balanced APFC.
Impact of wrong compensation on harmonics

With every step of APFC, PF improves and THD V also increases. % THD V increased from 5.12% to 6.28 % on application of 200 kVAR Balanced APFC.

Effects of Harmonics

High harmonics results in:
- Cable overheating in undersized cables
- Cable line loss in oversized cables
- Nuisance tripping of Breakers
- Resonance blow up of Capacitors.
- Damage to Power Transformer
- Malfunctioning of Electronic Controls and devices
Impacts of varying load on DG sets

- DG Sets are the most vulnerable to varying loads:
  - Oversized or undersized DG resulting in high fuel consumption or DG not taking load.
  - Production loss when DG not taking load
  - Increased inventory to cope up with power cuts
  - Poor Quality of products especially welding components - increased rejection
  - Poor Power Factor
Regulatory Initiatives

- Encourage customers to maintain a flat load profile.
- Bill customers on kVAHr instead of kWhr. PF incentive is withdrawn.
- Consumers above 500 kVA contract demand will have to declare Harmonic Levels and their plans to mitigate them. (Position varies from State to State).

Criteria - Appropriate PF Improvement solution

- Rate of Change of Load
- Capacitor Switching Technique
- Type of load – Balanced or Unbalanced
- Source Independency
- DG Compatibility
- Harmonic Mitigation
What do you need?

**The Solution should provide**
- Cycle to Cycle Compensation In 20 milliseconds
- Transient free switching
- Curtailing harmonics to desired levels
- Compatible to run on both **DG** and **EB** supply
- Maintain Unity Power Factor under Unbalanced loading conditions

Cummins can help you with a System having features

- Cycle-by-cycle reactive power compensation providing mirror image compensation
- Transient-Free Solid-state Capacitors Switching
- Energy Savings
- Compatible to both EB and DG
- Enhancement of generation capacity (DG Sets)
- Harmonic Filtration
- Prevention of Voltage drops, Reduction of Voltage Flickering
- Comprehensive Power Quality Analyzer
- Self testing and comprehensive reporting features
Thank You

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