Power Management in a “Green Factory”

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Mike Lin
Delta Products Corp.
Power Management Challenges in a “Green Factory”

Electricity price and consumption increase result in production cost increase.

Power Quality Management Presents Challenges to Factory Owners

Governments set up energy saving policy and environmental requirements for industrial factories and equipment.

Factory Automation helps tackle increasing labor costs and production efficiency.
Green Factory Automation
Factory Energy Saving Solutions

- Renewable Energy Micro-grid
- Energy Management System
- Unmanageable Industrial Ethernet Switch
- Programmable Logic Controller
- HVAC System
- Elevator Energy Saving System
- AC Motor and Drive (Applications on Injection Molding Machine, Air Compressor, Pump, Conveyor and Blower)
- Human Machine Interface
- AC Motor Drive
- Power Quality Management
- Web IP Camera
- BACnet
- MODBUS
- Unmanageable Industrial Ethernet Switch
- Ethernet
Green Factory Automation
Assembly Line Structure

Central Control Room
- PC
- Database
- Ethernet

Control Panel
- MODBUS
  - Conveyer Speed
  - Fluxing Width
  - Hand Insertion

Control Panel
- MODBUS
  - Conveyer Speed
  - Pressure
  - Speed

Control Panel
- MODBUS
  - Conveyer Speed
  - Temperature

Control Panel
- MODBUS
  - Hardware Controller
  - Coating Position Control

Control Panel
- MODBUS
  - Conveyer Speed
  - Temperature

Fluxing
- Wave Soldering
- Semi-finished Product Testing
- Conformal Coating

Conveyer Speed
- Drying
Power Quality Management in a “Green Factory”
Power Quality Issues at a Green Factory

- Grid / Transformer
- VFD
- UPS
- Motor
- Thyristor Rectifier
- Renewable Energy
- Switching Power Supply

No-Linear Load

- Oil & Gas Industry
- Electronics Industry
- Steel Industry
- Process Plants
- Automotive Industry

Reactive & Harmonic
What Is Reactive Power

Capacitive, inductive, and transient load cause the reactive power

- **Fundamental Reactive Power:**
  - Current is leading ¼ of the power cycle relative with the voltage \( U \) \( I \) \( \text{Leading Capacitive Current} \)
  - Current is lagging ¼ of the power cycle relative with the voltage \( U \) \( I \) \( \text{Lagging Inductive Current} \)
Harmonic:
- Sinusoidal voltages/currents that are integer multiples frequency of the power frequency
- Described by the complete harmonic spectrum with magnitudes and phase angles

No-linear device or load cause the harmonic current and voltage

ASD (Example of No-linear Load)

What Is Harmonic
Current Power Quality Challenges

Building, IDC, Industrial Field……

Main load:
Rectifier (VFD, UPS)
Motor, Linear PS

Power Quality Issue:
Harmonic + Reactive, Dynamic Reactive

Cap Cabinet:
Can not solve issue
But generate new problem
Current Power Quality Issues
Case Study I: Active Power Filter Solutions in a Copper Metallurgy Company
## Case Study I: Active Power Filter Solutions in a Copper Metallurgy Company

<table>
<thead>
<tr>
<th>Location</th>
<th>Before/After</th>
<th>Total Voltage (V)</th>
<th>Total Voltage THDV (%)</th>
<th>Total Current (A)</th>
<th>Total Current THDi (%)</th>
<th>PF</th>
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<tr>
<td>Before</td>
<td>221.13</td>
<td>6.5</td>
<td>941</td>
<td>28</td>
<td>0.84</td>
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<td>After</td>
<td>220.79</td>
<td>2.3</td>
<td>685</td>
<td>4.4</td>
<td>0.98</td>
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Case Study II: Active Power Filter Solutions In a Chemical Factory

Current without APF

THD without APF

Current with APF

THD with APF
Factory Energy Savings

- Injection Molding Machine
- Air Compressor
- Robotics
- Factory Waste Water Treatment
- Elevator
Injection Molding Machine Solutions
Injection Molding Machine Solutions

Hybrid Energy Saving System for Injection Molding Machine

Human Machine Interface

Temperature Controller

Programmable Logic Controllers

The energy consumption analysis

- Heating System: 10%
- Cooling System: 5%
- Control System: 5%
- HES System: 35%
- Regular hydraulic system: 80%

HES Energy Saving 45%
Air Compressor Solutions

Cost Analysis for Traditional Air Compressor

Human Machine Interface
DOP-B Series

AC Motor Drive
C2000

Programmable Logic Control

Cost Analysis for Air Compressor with Drive

Energy Cost 47%
Procurement Cost 17%
Maintenance Cost 6%

Energy Saving 30%

Cost Analysis for Traditional Air Compressor

Energy Cost 77%
Procurement Cost 12%
Maintenance Cost 11%
Factory Waste Water Treatment/Recycle Solutions

- Human Machine Interface
- Ethernet
- Programmable Logic Controllers
- Unmanageable Industrial Ethernet Switch
- Communication Modules
- AC Motor Drives
- Programmable Logic Controllers
- Connection to wastewater treatment equipment
- Device Net
- IO Writing
Elevator Energy Saving Solutions

- Energy-saving benefit (a green factory in Taiwan)
  Estimated power consumption of traditional elevator: 15,209 kWh
  Elevator power consumption: 9,179 kWh
  Estimated saved power: 6,030 kWh

- Energy saving: 40%

![Diagram showing energy saving solution](image)
Green Factory Applications
HVAC Air Conditioner energy saving successful applications

Rolled steel production line in Steel mill
- Project name: HVAC
- Location: Hubei
- Finish time: May, 2011
- Products: VFD, PLC

Dairy Group
- Project name: Ventilation System
- Location: Jilin
- Finish time: Jan, 2010
- Products: VFD

Chemical fiber factory
- Project name: HVAC
- Location: Jiangsu
- Finish time: Oct, 2011
- Products: VFD, PLC

Pharmaceutical Company
- Project name: Ventilation System
- Location: Jilin
- Finish time: Mar, 2010
- Products: VFD
Green Factory Solar Rooftop and EV Carport Kits

1) 63.36kW Rooftop Solar System (12 Strings)

2) 5.76kW Carport Solar System (24 panels, 2 EVCS’s, 1 LED) and Electric Transportation
Green Factory Smart LED Lighting Retrofit

- 2x2 40W Troffer (replacing 80W)
- 2x4 60W Troffer (replacing 160W)
- 2x4 60W Troffer (replacing 160W)
- 100W High Bay (replacing 250W)
- 60W Garage Light
Summary

- Unmanageable Industrial Ethernet Switch
- Renewable Energy Micro-grid
- Renewable Energy Micro-grid
- Energy Management System
- Programmable Logic Controller
- Industrial Ethernet Switch
- AC Motor Drive
- Cooling Tower
- Human Machine Interface
- Power Quality Management
- Lighting System
- Web IP Camera
- Automation System for Factory Production Lines
- Elevator Energy Saving System
- HVAC System
- Chiller
- Pump
- BACnet
- AC Motor Drive
- Air Handling Unit
- MODBUS
- AC Motor and Drive
(Applications on Injection Molding Machine, Air Compressor, Pump, Conveyor and Blower)