DANIELI DIGIMELTER
Q-ONE TECHNOLOGY

Efficient energy source for electric furnaces through Hi-performance power unit
A TECHNOLOGICAL BREAKTHROUGH IN THE EAF PROCESS AREA

Electric Arc Furnace represents one of the most intensive disturbing loads in the electric power transmission systems, it is featured by rapid changes in absorbed power that occurs especially in the initial phase of melting, during which the critical condition of an interrupted arc may become a short circuit or an open circuit. Actual furnaces design provides very large input ratings and due to nature of both, electrical arc and meltdown process, these equipment can generate large power quality problems on grid as non symmetric current & voltage, harmonics, flickers, voltage imbalances and drops, over voltages.

Conceived as innovative solution to supply the AC Electric Arc Furnaces, **Q-ONE** is a Danieli Automation’s designed and patented equipment that uses latest power electronics technology to handle irregular loads in a more flexible and reliable way, and values of power factor close to unity. **Q-ONE** extends the Power System products range to the high-power systems used for EAF steel melting, where well-known challenges have to be addressed:

> Hi-levels of active & reactive power absorbed from the electrical supply network in an unbalanced and untimely manner, causing huge disturbances (harmonics and flicker) affecting the proper functioning and operation of other connected loads;
> Efficient use of energy through process optimization with great room for improvements and savings;
> Suitability for existing EAF modernization projects, with a flexible power and control configuration to meet existing arc ratings and physical furnace shape.

The **Q-ONE** family of special power converters minimizes network disturbances, handle large load unbalances, and virtually absorb almost all active power in a balanced manner from the supply network. A specifically designed patented control system and configuration makes it possible to reduce the transients that are known to wear out the EAF components during the melting cycles, significantly reducing maintenance stops and the cost of wearable parts, and at the same time optimizing the melting process.
Very low network flicker due to real time control on the arc current variation.

Higher reliability of Q-ONE equipments because of its modularity and wide design margins.

Higher power factor thanks to a limited exchange of reactive power with MV network.
Impact onto the feeding network
Differently to a static var compensation system, the Q-ONE system acts onto the source of the conducted disturbances and not on their effect onto the network. The basic concept of Q-ONE is to separate the furnace working environment from the dedicated feeding network.

Q-ONE flexibility
> Extremely high speed control of voltage and current in the furnace
> Real time control of the supply voltage of EAF
> Real time control of the arc current thus of short circuit phenomena
> Possibility to run the furnace with two phases only, with zero impact to network
> Possibility to act onto the output frequency (typical 30 to 70 Hz)

Q-ONE reliability
> Rated voltage of Q-ONE equipment chosen with wide design margins;
> Possibility to easily exclude three-phase modules in case of fault;
> Possibility to easily exclude single units aboard Q-ONE modules in case of fault;
> Remote control via WEB for maintenance and data monitoring.

Q-ONE layout
On request, the Q-ONE system installation can be designed with the possibility to easily switch between the existing furnace feeding system and the new one. The existing furnace transformer can be disconnected from the secondary and moved backwards, whilst the primary side can be isolated.
by acting onto the copper bars of the feeding line.
The layout of the new Q-ONE feeding system is chosen and designed to limit the impact onto the existing electrical and mechanical equipment.

**Q-ONE equipment features**

> Reduced global power with respect to the equivalent furnace transformer;
> Suitable arrangement of vector groups to highly compensate harmonics;
> High flexibility by handling unbalanced loads.
> Solution studied to keep AC furnace in operation with existing mechanical part;
> High modularity inside a single phase-module and within the whole valve;
> Suitable current redundancy;
> High flexibility by settling the output voltage;
> Easy maintenance and component replaceability (equipment components available on the market)
> High level of safety by disconnecting and grounding the furnace load during maintenance;
> High flexibility by disconnecting single modules of Q-ONE in case of fault.

**Q-ONE maintenance**
The Q-ONE system with its installation was designed with utmost care to ensure simple removal of the inverter and converter units, thus guaranteeing easy inspection and maintenance of the main components.

**Q-ONE savings**
With the adoption of Q-ONE power converters to feed an Electric Arc Furnace, a consistent reduction in electrode consumption can be expected, estimated to be around 20%, as well as a drastic reduction in power on time, about 10%.

Thanks to a less installed apparent power, a consistent process energy saving is easily achievable (estimated in about 10%) with remarkable and substantial economical benefits.

**Return of investment**
In the light of the above, the ROI for a complete economical feedback is variable from country to country and can be estimated to be between 9 to 24 months.

---

1. The Q-ONE basic concept
2. Q-ONE equipment and modules design (*) upgrade to 5KA under study
3. Impact onto the feeding network
4. Power factor
   - Q-ONE EAF Power factor
   - Transformer EAF Power factor

---

ROLE OF DC LINK AS SOURCE OF REACTIVE POWER TO THE FURNACE
LIMITED EXCHANGE OF REACTIVE POWER WITH THE MV NETWORK
REAL TIME CONTROL ON THE ARC CURRENT BEHAVIOUR
## Benefits & Savings

### Performance Savings

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;10%</td>
<td>Overall process energy savings</td>
</tr>
<tr>
<td>&gt;20%</td>
<td>Electrode consumption</td>
</tr>
<tr>
<td>&gt;10%</td>
<td>Power-on time</td>
</tr>
<tr>
<td>&gt;10%</td>
<td>Noise reduction (at constant level)</td>
</tr>
</tbody>
</table>

### Operational Benefits

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HI-SPEED</td>
<td>Control of voltage &amp; current</td>
</tr>
<tr>
<td>HIGHER</td>
<td>Furnace power factor</td>
</tr>
<tr>
<td>VERY LOW</td>
<td>Network flicker</td>
</tr>
<tr>
<td>TOP</td>
<td>Reliability design modularity</td>
</tr>
</tbody>
</table>

### Installation Savings (due to unrequired equipment)

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SERIES</td>
<td>Reactors</td>
</tr>
<tr>
<td>EAF</td>
<td>Transformers</td>
</tr>
<tr>
<td>SVC</td>
<td>Static var compensator</td>
</tr>
<tr>
<td>FURNACE</td>
<td>Breaker</td>
</tr>
</tbody>
</table>

### Maintenance and Installation Benefits

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW IMPACT</td>
<td>On existing electrical equipment</td>
</tr>
<tr>
<td>HIGH LEVEL</td>
<td>Of safety</td>
</tr>
<tr>
<td>EASY</td>
<td>Maintenance operations</td>
</tr>
<tr>
<td>REMOTE</td>
<td>Control via web</td>
</tr>
</tbody>
</table>

[Image of electrical equipment and a worker in a hard hat and safety gear, possibly indicating the installation of electrical systems.]