SVC
Static Var Compensator

The key to better arc furnace economy
The key to producing more steel...

An electric arc furnace requires a stable and steady voltage supply for optimum performance. An SVC can instantaneously compensate the random variations of reactive power so characteristic of an arc furnace load. The net result is an overall improvement in arc furnace utilisation.
...at a lower cost per tonne...

...is a Static Var Compensator (SVC)

Reactive power compensation through an SVC helps you to obtain the following benefits:

A higher voltage level at the furnace busbar gives:
* shorter meltdown times
* reduced energy losses
* reduced electrode consumption
* extended life of furnace lining

Improved power factor to:
* benefit from lower utility penalties
* utilise existing electrical plant more effectively
* lower plant losses

Stabilisation of voltage and reduction of harmonics and phase unbalance to minimise:
* disturbances in nearby electrical equipment as well as in the feeding grid
* maloperation of protection devices
* negative sequence currents in motor circuits

By installing an SVC on the furnace busbar to instantaneously compensate the furnace’s large and continuously varying reactive power demand, troublesome voltage drops and fluctuations can be avoided. The mean power input to the arc furnace is raised, and nearby electrical equipment can operate as usual. The curves show the furnace busbar’s voltage with and without SVC.
SVC provides a high and stable bus voltage

An electric arc furnace is a complex and heavy load in a power grid. It is a large, unbalanced, and strongly fluctuating consumer of reactive power. These reactive power fluctuations, which are very marked, especially at the beginning of the melting operation, lead to voltage reductions that reduce the active power to the arc furnace and also to other loads connected to the same feeding busbar. The furnace power varies with the square of the feeding voltage and it is thus very important to keep the voltage high and stable. With a Static Var Compensator the reactive power variations are compensated within a few milliseconds and also individually in each phase, providing a balanced and stable voltage.

The reactive power needed by the arc furnace is compensated by a thyristor controlled reactor which in combination with fixed capacitor banks on a cycle-by-cycle basis, produces almost a mirror image of the furnace current.

ABB can offer many features and options so as to provide the optimum solution for each customer.

Examples:

* Direct connection to the busbar that is to be compensated. No need for a stepdown transformer. This is valid for all existing EAF bus voltages up to 69 kV.
* Trigger pulses for the thyristors derive their energy from parallel circuits over the thyristors and are controlled by light pulses transmitted via fibre optics.
* A fully computerized control system. High performance industrial standard buses and fibre optic communication links are utilized.
* The thyristor valves are of indoor type, water-cooled for efficiency and compactness.
Unique experience from the steel industry

• Since 1972, ABB has been supplying Static Var Compensators to arc furnaces in steel mills all over the world.

• We have been involved in design and manufacture of industrial furnaces for almost a century and our metallurgists and engineers are specialists in the metallurgical process and the problems involved in arc furnace applications.

• We have our own research, development and manufacturing facilities for both components and systems.

• We have a world-wide after-sales service organisation and local engineering and manufacturing companies in many countries.

ABB holds the key to the best reactive power compensation solutions. Consult us to find out exactly how much you will benefit by installing a Static Var Compensator – it’s usually a very pleasant surprise!
SVC Light: *the best combination of productivity improvement and flicker mitigation*

VSC: a controllable voltage source

The basic constituent of SVC Light, the VSC, is a fully controllable voltage source matching the bus voltage in phase and frequency, and with an amplitude which can be continuously and rapidly controlled, so as to be used as the tool for reactive power control and flicker mitigation. It is IGBT based.

The input of the VSC is connected to a capacitor, which is acting as a DC voltage source. At the output, the converter is creating a variable AC voltage. This is done by connecting the positive pole, neutral or the negative pole of the capacitor directly to any of the converter outputs. In converters that utilize Pulse Width Modulation (PWM), the input DC voltage is normally kept constant. The amplitude, the frequency and the phase of the AC voltage can be controlled by changing the switching pattern.

The output of the VSC is connected to the AC system by means of a small reactor. By control of the VSC voltage ($U_2$) in relation to the bus voltage ($U_1$), the VSC will appear as a generator or absorber of reactive power, depending on the relationship between the voltages. To this controlled reactive power branch, an offsetting capacitor bank is added in parallel, enabling the overall control range of the SVC Light to be capacitive.
Cutting of production costs

By increasing the active power available to an arc furnace a Static Var Compensator can cut the meltdown time ($T_{\text{md}}$) by up to 30%. $T_{\text{md}}$ can be calculated using this formula:

$$T_{\text{md}} = \frac{G \times W \times 60}{F \times P} \text{ minutes}$$

where $G = \text{charge weight (tonnes)}$  
$W = \text{specific energy consumption (kWh/tonne)}$  
$F = \text{utilisation factor, approx. 0.8}$  
$P_i = \text{furnace power applied, without compensation}$  
$P_j = \text{furnace power applied, with compensation}$

As a result of increased active power to the furnace, the reduction meltdown time will be:

$$\Delta T_{\text{md}} = \frac{G \times W \times 60}{0.8} \times \frac{P_j - P_i}{P_i \times P_j}$$

By improving the utilisation of existing plant, not only are operating costs cut, but it will be longer before additional plant needs to be aquired. During periods of low utilisation, overheads can be trimmed by reducing the number of furnaces on line, while still achieving the same level of production.

- Reduced electrode consumption
- Reduced energy consumption
- Reduced costs of furnace lining

All in all, SVC pay-back times of a year or even less are attainable in many cases.

**A typical example**

<table>
<thead>
<tr>
<th>SVC (MVA)</th>
<th>Without SVC</th>
<th>With SVC</th>
<th>Improvement %</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAF 50 MVA, 65 tonnes</td>
<td>SVC (Mvar) - 60</td>
<td>Power factor 0.71</td>
<td>1</td>
</tr>
<tr>
<td>Voltage drop (%)</td>
<td>10</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Power into scrap (MW)</td>
<td>20.2</td>
<td>26.7</td>
<td>32</td>
</tr>
<tr>
<td>Energy (kWh/tonne)</td>
<td>406</td>
<td>481</td>
<td>3</td>
</tr>
<tr>
<td>Tap-to-tap time (hours)</td>
<td>1.6</td>
<td>1.33</td>
<td>17</td>
</tr>
<tr>
<td>Steel production (th. tonnes/year)</td>
<td>200</td>
<td>343</td>
<td>22.5</td>
</tr>
<tr>
<td>Electrode consumption (kg/tonnes)</td>
<td>3.5</td>
<td>3.2</td>
<td>9</td>
</tr>
</tbody>
</table>

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**Active power into furnace**

**Potential benefits**

**Other benefits**