Arc Suppression Coils
THE PROVEN POWER.
Introduction

The most common type of failure in an electrical power distribution network is a single phase-to-earth fault. Many utilities are successfully mitigating the effects of this type of fault by the use of earth-fault compensation systems.

In this scheme the system neutral is earthed through a high impedance reactor, a so called arc suppression coil (Petersen coil), which is adjusted to the earth capacitance of the network.

By utilizing continuously variable arc suppression coils, ideal compensation of the earth-fault current, and therefore optimal efficiency of the resonant earthing technique can be achieved.
Arc Suppression Coil (ASC)

Since the topology of an electrical power distribution network is subject to dynamic changes, the inductance of the arc suppression coil used for neutral earthing must be variable. Two basic principles to vary the inductance exist:

- by performing switching operations on the reactor whereby coil sections are connected or disconnected (step coil), or
- by continuous variation of the reluctance of the magnetic circuit by means of a mechanical drive (plunger core coil).

The earth-fault protection system developed by Trench Austria favours the plunger core coil compared to a reactor which is adjustable in finite steps, as

- no switching operations for inductance variation are required (preferable since switching can easily lead to network perturbations during earth fault) and
- plunger core coils can be tuned precisely to minimum current at the fault location due to their continuous variability.

Based on years of experience in the construction of arc suppression coils, the coil design concept was thoroughly reviewed, resulting in a new and improved series of ASCs which meet today’s requirements for earth-fault compensation. By means of modern planning and production processes substantial cost savings for plunger core coils were also achieved.

The plunger core coil approach provides the following advantages:

- continuously variable (in onload condition) by means of variation of the air gap
- the adjustment is accomplished by means of a motor drive unit which may be either locally or remotely controlled.
- automatic tuning to the actual network condition via an earth-fault compensation controller
- current regulation range standard 1:10 (other ranges on request)
- as current regulation is not achieved by connecting or disconnecting winding segments the core induction is practically constant within the whole regulation range and slightly below saturation. As a consequence overvoltages in the system are limited.
- compact construction
Basic Sketch

Fig. 2 Basic sketch of an arc suppression coil
## Technical Data

<table>
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<tr>
<th>Technical Data</th>
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<tbody>
<tr>
<td>power range</td>
<td>100 kVAR – 35 MVAr</td>
</tr>
<tr>
<td>voltage range</td>
<td>up to 145/√3 kV</td>
</tr>
<tr>
<td>insulation level</td>
<td>uniform insulation or graded insulation, graded insulation</td>
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<tr>
<td>( U_{IS} \leq 36 \text{kV} )</td>
<td>( U_{IS} &gt; 36 \text{kV} )</td>
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| duty                   | • 2 hours short time duty  
                          | • continuous duty |
| current regulation range | 10 % – 100 %      |
| rated frequency        | 50 Hz (60 Hz on request) |
| cooling method         | ONAN (self cooling) |
| installation           | indoor or outdoor  |

*Fig. 3  20 kV Arc Suppression Coil*
Standard Design and Outfit

- Iron cored, oil insulated coil with continuously variable air gap adjustment in on-load condition by means of a plunger core
- Suitable for automatic earth-fault compensation via the Trench Austria earth-fault compensation controller EFC50/EFC50i (see accessories)
- Motor drive unit: Trench Austria model DMA, 230/400 V, 50 Hz, (control voltage 230 V, 50 Hz), mounted on top of the tank, with hand-crank for emergency service and potentiometer for remote position indication, with separate control cabinet mounted on the side wall of the tank at operational height
- In oil-filled steel tank with air cushion, corrugated steel tank up to 3150 kVAr, steel tank from 4000 kVAr
- Oil-filling: mineral oil on naphthenic basis, PCB-free, accord. to IEC 60296 : 2003
- Mobile base with bidirectional rollers
- Porcelain bushings as per EN 50180; for Um > 36 kV condenser bushings
- Protective cap over low voltage bushings
- Voltage measuring winding 100 or 110 V / 3 A
- Power auxiliary winding (500 V, 5 % of coil power, 30 s short time duty) for current injection used for the Trench Austria earth-fault protection system EPSY (for a detailed description refer to our brochure EPSY Earth-Fault Protection System)
- One additional pocket for oil temperature indicator as per DIN 42554
- Oil gauge without indicating contacts
- Dehydrating silicagel breather
- Surface treatment according to DIN EN ISO 12944-5, system no. A1.11, top coat colour grey as per RAL 7033

Routine Tests

- Measurement of winding resistance
- Measurement of current over the whole adjustment range
- Measurement of voltage ratio between main winding and secondary windings
- Separate-source power frequency voltage test
- Induced overvoltage test
- Operation tests of core air gap mechanism

Type Tests

- On request, as per agreement
Special Design/Optional Equipment

- steel tank with flange mounted radiators
- with detachable oil conservator (OC)
- double float Buchholz relay as per DIN 42566 (only with OC)
- various insulating fluids
- current transformer
- power auxiliary winding (with extended power rating, continuous or short time duty)
- devices for temperature supervision
- minimum oil level indicator with indicating contacts (without OC)
- magnetic type oil level indicator with/without indicating contacts (only with OC)
- plug-in cable termination system
- surge arrester
- different motor drive types
- alternative motor voltages
- devices for remote indication
- supplementary resistor mounting brackets/hardware (only in connection with a corresponding power auxiliary winding)

Fig. 4  77kV, 31500 kVAR, short time duty 2 h
Special ASC Design

- air insulated resistor for resistive residual current increase (see accessories)
- skid base
- hot galvanized
- paint/colour as per customer’s specification

Sliding Core ASC
Simplified design for a power range within 100-1250 kVAr, current regulation range 1:5 with hand or motor drive. Optional equipment as per plunger core ASCs.

Neutral Earthing Aggregate
Compact construction of an arc suppression coil and a corresponding earthing transformer, housed in a common oil-filled steel tank. For a detailed description refer to our brochure Neutral Earthing Aggregates.

Fixed Core ASC
Iron core coil with multiple sub-divided air gap for compensation of invariable network sections, without adjustment device.

Dry Type ASC/Neutral Earthing Aggregat
Design with epoxy resin impregnated windings.

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<td>power range</td>
<td>up to 1250 kVAr</td>
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<tr>
<td>voltage range</td>
<td>up to 10 kV</td>
</tr>
<tr>
<td>insulation level</td>
<td>graded insulated to 1 kV max. BIL 60 kV</td>
</tr>
</tbody>
</table>
| duty                           | • 2 hours short time duty  
|                               | • continuous duty |
| current regulation range       | 10 % – 100 % |
| rated frequency                | 50 Hz |
| cooling method                 | AN |
| installation                   | indoor |

Fig. 5  Dry Type Neutral Earthing Aggregate 6 kV, 400 kVAr
Accessories

Shunt Resistor

In order to eliminate earth faults rapidly, the faulty feeder has to be detected quickly and selectively. One approach for detection of low-ohmic earth faults is the recognition by means of wattmetric directional relays.

When this approach is used it is sometimes necessary to increase the residual earth-fault current via a low voltage shunt resistor connected to the power auxiliary winding of the ASC.

Fig. 6 Air cooled resistor in stainless steel enclosure, protection class IP23, built on to the ASC base, electrically connected to the power auxiliary winding, including contactor and thermal overload protection.

Earth-Fault Compensation Controller EFC50

When changes occur in the network topology the arc suppression coil must be immediately adjusted to the modified network. This task is achieved by the Trench Austria earth-fault compensation controller EFC50 through adjustment of the inductance of the ASC to the actual system earth capacitance.

For a detailed description refer to our brochure Earth-Fault Compensation Controller EFC50 / EFC50i.

Electronic Resistor Control EZA3

The electronic resistor control EZA3 is used for controlling a low voltage shunt resistor which is connected to the power auxiliary winding of the arc suppression coil. It also protects the resistor and the power auxiliary winding of the ASC from thermal overload.

Fig. 7 Earth-Fault Compensation Controller EFC50
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