Arc Suppression Coils

TRENCH

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 earthfault 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 earthfault current, and therefore optimal efficiency of the resonant earthing technique can be achieved.

Fig. 1 110/20 kV Substation with arc suppression coils

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 earthfault 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 earthfault) 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 earthfault 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 on-load 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 earthfault compensation controller

- 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

Principle Construction

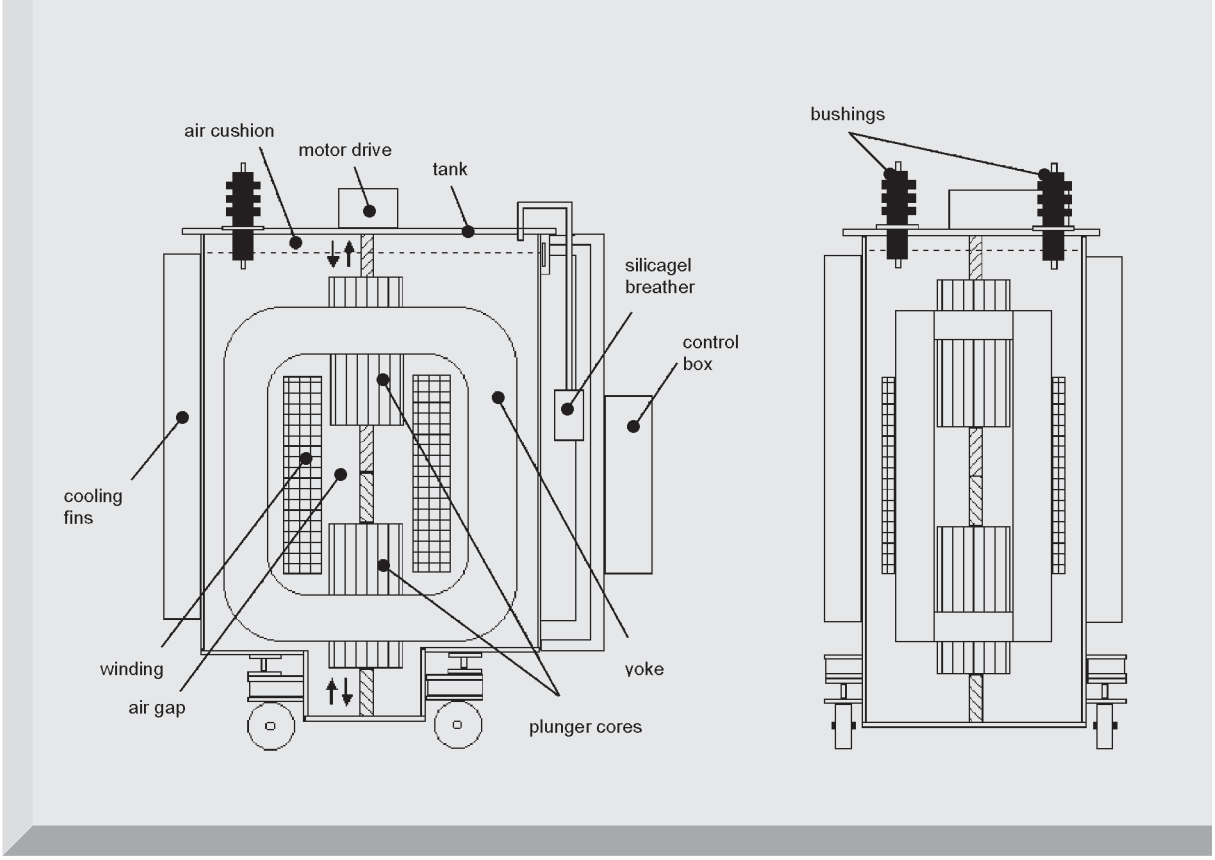

Fig. 2 Principle construction of an arc suppression coil

Technical Data	
power range	200 kVAr – 35 MVAr
voltage range	up to 145/√3 kV
insulation level rated voltage up to 36 kV rated voltage > 36 kV	 fully insulated or graded insulated graded insulation
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 10 kV Arc suppression coil

Standard Design / Equipment

- iron cored, oil insulated coil with continuously variable air gap adjustment in on-load condition by means of a plunger core

- suitable for automatic earthfault compensation via the Trench Austria earthfault compensation controller EFC20/EFC20i (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 corrugated steel tank with air cushion

- oil-filling: mineral oil on naphthenic basis, PCB-free, accord. to IEC 60296 : 2003

- mobile base with bi-directional rollers

- porcelain bushings as per DIN; for Um > 36 kV condenser bushings

- protective cap over low voltage bushings

- voltage measuring winding 100 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 earthfault protection system EPSY (for a detailed description refer to our brochure *EPSY Earthfault Protection System)*

- one additional pocket for oil temperature indicator as per DIN 42554

- oil gauge without indicating contacts

- dehydrating silicagel breather

- surface treatment with 4-fold coating, 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

Fig. 4 $110/\sqrt{3}$ kV, 8000 kVAr, continuous duty

Special Designs / 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

Special ASC Designs

- alternative motor voltages
- devices for remote indication
- supplementary resistor mounting brackets/hardware (only in connection with a corresponding power auxiliary winding)
- air insulated resistor for resistive residual current increase (see accessories)
- skid base
- hot/spray galvanized
- paint/colour as per customer's specification

Sliding Core ASC

Simplified design for a power range within 200-1250 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.

Accessories

Shunt Resistor

In order to eliminate earthfaults rapidly, the faulty feeder has to be detected quickly and selectively.

One approach for detection of low-ohmic earthfaults is the recognition by means of wattmetric directional relays. When this approach is used it is sometimes necessary to increase the residual earthfault current via a low voltage shunt resistor connected to the power auxiliary winding of the ASC.

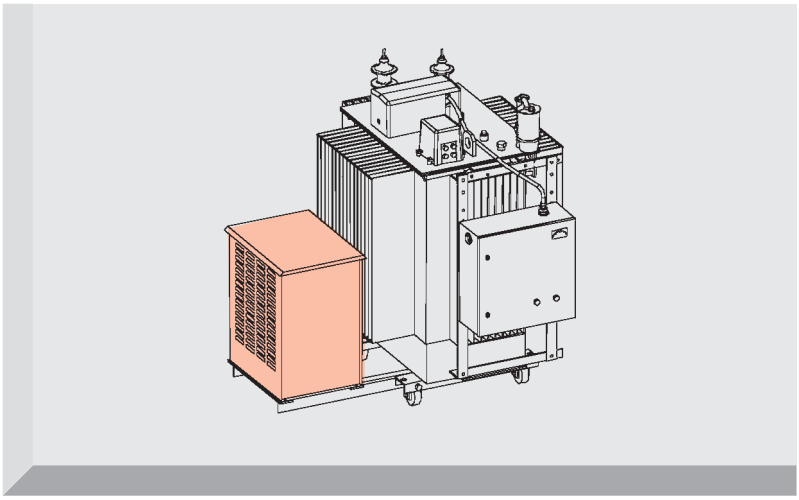

Fig. 5: air cooled resistor in stainless steel enclosure, protection class IP23, built on to the ASC base, electrically connected to the power auxiliary winding, including contactor and thermal overload protection.

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. 6 Resistor control EZA3

Earthfault Compensation Controller EFC20

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 earthfault compensation controller EFC20 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 EFC20 / EFC20i.*

Fig. 7 Earthfault compensation controller EFC20

☐ Trench Austria GmbH
Paschinger Straße 49, Postfach 36
A-4060 Linz-Leonding/Austria
Phone +43.732.6793-0
Fax +43.732.67 13 41
email sales@trench.at

☐ Trench Limited
Instrument Transformer Division
390 Midwest Road, Scarborough
Ontario, Canada M1P 3B5
Phone +1.416.751-8570
Fax +1.416.751-6952
email sales@ca.trenchgroup.com

☐ Trench Limited
Coil Product Division
71 Maybrook Drive, Scarborough
Ontario, Canada M1V 4B6
Phone +1.416.298-8108
Fax +1.416.298-2209
email sales@ca.trenchgroup.com

☐ Trench France S.A.
16, rue du Général Cassagnou
B.P. 70
F-68302 St-Louis/France
Phone +33.3.89 70 23 23
Fax +33.3.89 67 26 63
email sales@trench.fr

☐ Trench Germany GmbH
Nürnberger Straße 199
D-96050 Bamberg/Germany
Phone +49.951.1803-0
Fax +49.951.1803-224
email sales@trench.de

☐ Trench Switzerland AG
Lehenmattstraße 353
CH-4052 Basel/Switzerland
Phone +41.61.315 51 11
Fax +41.61.315 59 00
email sales@trench-tsf.com

www.trenchgroup.com

☐ Trench (UK) Limited
South Drive
Hebburn
Tyne & Wear
NE 31 1 UW, Great Britain
Phone +44-191-483-4711
Fax +44-191-430-0633
email sales@trench-uk.com

☐ Trench Brasil LTDA
Via Expressa de Contagem, 2685
CEP 32370-485
Contagem, Minas Gerais/Brasil
Phone +55.31.391-5959
Fax +55.31.391-1828
email trenchbrasil@ca.trenchgroup.com

☐ Trench China Limited
3658 Jiang Cheng Road
Minhang, Shanghai 200245
P.R. China
Phone +86.21.64630088
Fax +86.21.64637828
email sama@trenchcn.com

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