PRODUCT INFORMATION

HVDC-BUSHING WITHOUT OIL SIDE PORCELAIN TYPE GOF

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The bushing shall be de-energised and grounded when any kind of work is carried out on the bushing.
Description

Design

The design principle is shown in Figure 1.

The bushing is built without insulator on the oil side, that means that the bushing share the oil with the transformer. The air side porcelain has flanges in the top and the bottom ends that are cemented to the porcelain. The top cover and the fastening flange are bolted to these flanges. The condenser body is wound on its own tube, concentrically mounted to the conductor tube and fixed by means of a clamping device that is bolted to the fastening flange.

The center tube is made of aluminium or copper. This tube is used as the current conductor. The transformer leads are bolted by means of cable lugs to a bottom contact, made of copper. This contact is drawn against lower end of the bushing tube by an aluminium/steel rod. See figure 9 for the design of the draw rod for aluminium conductors. If the conductor is made of copper the draw rod has additional bolts of steel. This combination of steel and aluminium have approximately the same linear expansion due to the operating temperature as the copper conductor. The draw rod is connected to a spring device and bolted to the top of the bushing. This system gives the required contact pressure between the bottom contact and the conductor tube at all expected service conditions. The outer terminal is made of aluminium.

During transport and storing the bottom part of the bushing is protected by a transport container.

An oil seal is included between the fastening flange and the condenser body. This seal prevents oil from flowing out from the transformer in case of damage to the porcelain insulator. The seal is equipped with pressure valves that allows transportation of oil from one side of the seal to the other side at temperature differences in the bushing. A detailed description of the pressure valves is given in the paragraph "Description of sealing system" below. In service, the bushing is designed to share the oil system with the transformer.

Spare parts

In case of major damage to the bushing, it shall be sent back to ABB Components AB for repair and re-testing.

For certain parts that may be lost or damaged in transportation or handling, the article numbers or the dimensions are given in the Figures.
Figure 1. Bushing design
Voltage tap In the mounting flange, a voltage tap is mounted that is insulated from the flange and connected to the outermost layer of the condenser body. The voltage tap must always be earthed or connected to an impedance. The voltage tap is shown in Figure 2.

**Figure 2a.**

1. Test tap 2769 522-T
2. Test tap cover 2769522-M
3. Sealing plug 2522 731-A

**Figure 2b** Terminal box (ABB Art. nr 2769 522-C)
Description of the sealing system

The bushing is mounted almost in horizontal position. The air side penetrates the valve hall.

In order to prevent oil from flowing out from the transformer into the valve hall, the bushing has a sealing system built in between the fastening flange and the condenser body. In the sealing system pressure valves are mounted. These valves remain closed in case of damage to the porcelain. Rapid changes in temperature causes the valves to open in the following manner:

As the oil conservator of the transformer is exposed to open air via a silica gel breather, increase of pressure in the transformer tank due to temperature differences is not possible.

1. The temperature rises in the air side of the bushing: The pressure in the air side of the bushing increases until it reaches a pre-set value. Valve 2 opens and oil flows from the bushing into the transformer.

2. The temperature goes down in the air side of the bushing: The pressure in the air side of the bushing decreases until it reaches a pre-set value. Valve 1 opens and oil flows from the transformer into the bushing.

3. The air side porcelain is totally cracked: The valves remain closed and no oil can flow from the transformer into the valve hall. See table 1 for the volume of oil that is enclosed in the air side of the bushing.
Service and maintenance

Capacitance and dissipation factor measurements

The desired capacitance and dissipation factor (tan δ) measurements can be carried out, without removing the bushing from the transformer, because the GOF bushings are furnished with a test tap. See figure 1.

With the transformer de-energised and the bushing terminal disconnected, the test tap cover is removed and the measuring equipment is connected to the tap and measuring voltage source is applied to the bushing terminal. The dissipation factor varies with the temperature of the bushing body and the measured value should thus be multiplied with the correction factor (multiplier) given below.

<table>
<thead>
<tr>
<th>Bushing body temperature (°C)</th>
<th>Multipliers to 20°C (IEC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 - 7</td>
<td>0.85</td>
</tr>
<tr>
<td>8 - 12</td>
<td>0.90</td>
</tr>
<tr>
<td>13 - 17</td>
<td>0.95</td>
</tr>
<tr>
<td>18 - 22</td>
<td>1.00</td>
</tr>
<tr>
<td>23 - 27</td>
<td>1.05</td>
</tr>
<tr>
<td>28 - 32</td>
<td>1.10</td>
</tr>
<tr>
<td>33 - 37</td>
<td>1.15</td>
</tr>
<tr>
<td>38 - 42</td>
<td>1.20</td>
</tr>
<tr>
<td>43 - 47</td>
<td>1.25</td>
</tr>
<tr>
<td>48 - 52</td>
<td>1.30</td>
</tr>
</tbody>
</table>

Mounting instruction

Packing

The bushings are delivered from ABB Components in wood cases with the bushing supported by cellular blocks and fibre boards. The case is marked with "Top End". On receiving, the bushing shall be inspected with regard to shipping damages.

Storing

The bushing may be transported and stored horizontally up to 6 months. The bushings should always be kept dry and clean and protected against mechanical damages during storing. Storing of the bushing longer than 6 months shall always be done leaned with the top end of the bushing upwards at an angle of at least 5°. The time between delivery from ABB Components to mounting of the bushing in a transformer is often longer than 6 months. It is therefore recommended that the case with the bushing is placed leaning at an angle of at least 5° when delivered to site.

The bushings can be stored outdoor in the cases provided they are protected against penetrating water. This means that the case must not be stored in areas where it can be foreseen that the ground will be wet and muddy during heavy rains. It is also recommended to use a tarpaulin to protect the case from water penetration.

Storing of spare bushings

Spare bushings are recommended to be stored mounted in a frame that gives the bushing a mounting angle of at least 5° from the horizontal. Preferably the bushings can be stored vertically.

If the bushing is stored in the case it must be leaned with the top end of the bushing upwards at an angle of at least 5°.

The bushings must be stored indoor in a dry and clean atmosphere and protected against mechanical damages.
Lifting

When lifting of the bushing out from the case, two lifting slings shall be used as shown in Figure 5. The lifting sling is not allowed to be placed around the sheds because of the risk to damage the sheds. Place the bushing on the ground supported under the same places as in the case using the same blocks. The oil drain plug in the transport container shall be placed upwards.

Mounting

The bushing shall be completely drained from oil before mounting in the transformer. With the bushing in horizontal position, hoses are connected through the drain hole in the transport container (max. diameter 230) and in the hole in the top cover of the bushing (one valve has to be removed) (max. diameter 213) so that the oil can be sucked out from the lowest level in each part of the bushing. Always use clean and undamaged hoses.

The lower part of the draw rod, that shall be mounted in the bushing turret, is usually mounted inside the transformer and is held during transportation by a special bracket in the transport cover. Before mounting of the bushing, this cover shall be opened and the bracket loosened after which the bracket and the cover are removed.

Disassemble the outer terminal and the seal seen in Figure 4. Place the box spanner over the flexible pull through lead, Figure 9 after which the lead is connected to the upper part of the draw rod. The draw rod is then inserted in the bushing centre tube. Mount the lifting tool according to Figure 7 and lift the bushing according to Figure 6. Loosen the bolts in the transport container and lift the bushing out of it. Lean the bushing to the mounting angle. Lower the draw rod so that the connection of upper and lower part can be done. The bushing is now ready to be mounted in the transformer. The draw rod is mounted according to Figure 8 and 9. The threads in the rods shall be cleaned and the joint locked with locking fluid 1269 0014-410 (Loctite) and activator Loctite T 747. When the draw rod is assembled, the bushing can be inserted in the transformer. Approximately 120 mm before final position the guiding cone at the bottom contact enters the bushing tube. Be careful so that the connection in the transformer is not damaged. Instructions for assembling the shielding system of the transformer is given in the Product information for the transformer.

Check that the valves in top of the bushing are closed.

The condenser body must not be exposed to open air for more than 2 hours. However, the bushing is allowed to be without oil up to one week if it is mounted in the transformer or in the transport container. If it is necessary, this time may be prolonged up to maximum tree weeks provided that the vacuum time for the transformer is increased with additional 24 hours and to have at least 5 days from the impregnation is complete (the oil level is above the bushings) to service voltage is applied.

After bolting the bushing to the transformer, the draw rod is finally mounted according to figure 8. The threads and the nut shall be lightly oiled before assembly. Try the nut on the rod to be sure that it can be threaded on easily. The jack is then connected and a tensile force of 40 kN is applied. Tighten the nut by hand with the box spanner. The jack is then released and removed.
Mounting of outer terminal

First mount the sealing plug according to Figure 4. The inner contact surfaces, both on the bushing tube and on the terminal stud, are tin plated Therefore no wire brushing or contact grease is needed.

The surfaces shall be cleaned carefully before assembly. The gasket retainer ring, the gasket itself and the outer terminal stud is assembled according to Figure 4. The bolts that press the stud against the bushing tube shall be tightened first. Tightening torque 40 Nm. When this is done, the screws that hold the retainer ring are inserted and tightened in order to press the gasket into place.

Figure 4. Outer terminal and sealing plug

It is extremely important in both cases to tighten evenly. The bolts shall thus be tightened in steps, alternating on both sides.

Mounting of external connections
The outer terminal is made of aluminium. Before connection of conductor clamps, the aluminium stud must be carefully wire brushed and greased with a proper contact compound.

Oil filling
Before oil filling of bushings and transformer, hoses are connected to the oil filling valves in top of the bushings and to the vacuum/oil filling equipment. When the bushing is completely oil filled, the valves are closed and the hoses removed. The hole in the valves shall be plugged with sealing plug 2522 2028-4 and thread tape.
Dismounting of bushing from transformer

After dismounting of the bushing from the transformer the transport container shall be mounted. The bushing and the transport container are then filled with dry clean transformer oil after which the expansion volume according to table 1 is removed from the top of the bushing. The valves in the top of the bushing are then closed and plugged. The sealing plug and the outer terminal must be mounted.

The bushing is then stored leaned with the top cover upwards in an angle $>5^\circ$.

If your bushing is not in the table below contact ABB Component for correct information.

<table>
<thead>
<tr>
<th>Type of bushing</th>
<th>Drawing number</th>
<th>Oil volume to be removed</th>
<th>Oil volume on the air side of the bushing</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOF 1550</td>
<td>2745 322-AZ</td>
<td>95 litres</td>
<td>425 litres</td>
</tr>
<tr>
<td>GOF 1550</td>
<td>2745 322-BB</td>
<td>95 litres</td>
<td>425 litres</td>
</tr>
<tr>
<td>GOF 935</td>
<td>2745 322-AY</td>
<td>70 litres</td>
<td>370 litres</td>
</tr>
</tbody>
</table>

Table 1.

Figure 5. Lifting of bushing out of case
Flexible pull through lead
ABB Art. No 9750 669-A

Hexagon nut M16
Box spanner ABB Art.No.9760 669-B
Conical washer 17x39x4
Washer 17x45x3
Washer of insulating material
16x76x3
Draw rod, upper part

Hydraulic pump with manometer

The nut shall be mounted so that the free thread above it is > 10 mm

Figure 8:
Jack (12 tons) with accessories (Manometer class 2,5)
ABB Art.No. 9769 897-A

The applied tensile force on the draw rod with the jack shall be 40 kN. Tighten the nut just by hand with the box spanner.
The jack is then released and removed.
Note that the sealing plug, figure page 8, shall be mounted.

Clean the threads from oil and lock the joint with Locite 242 and activator T 747.

Draw rod, lower part

Guide cone ABB Art. No. 4649 134-3 for aluminium conductor max. diameter 74 mm
ABB Art. No. 4649 134-6 for copper conductor max. diameter 68 mm

Bottom contact

Clean the threads from oil. Lock the joint with Locite 242 and activator T 747.

Figure 9. Mounting of draw rod