NATIONAL INSTITUTE FOR RESEARCH DEVELOPMENT
AND TESTING IN ELECTRICAL ENGINEERING
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Systems for compensation the capacitive reactive energy of electric cables

1. Scope. Description

The systems for compensating the capacitive reactive energy are intended to compensate the capacitive contribution of electric cables. For compensating the capacitive contribution of three phase cables, 3 (three) identical single phase shunt coils, star connected, with isolated neutral are used. The plane layout of the three identical coils can be achieved either in the corner of a triangle or in line. In both situations, the minimum distance between the axes of two adjacent coils should be equal with 2.2 D, where D is the outside diameter of the coil. Also, the minimum distance between the winding ends and the ferromagnetic parts existing in the enclosure structure should be of minimum 0.55 D.

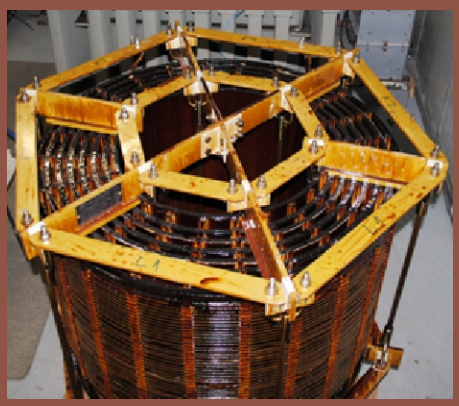
2. Technical characteristics

The system for compensating the capacitive reactive energy is made of the following elements:
a) one set of three identical, indoor single phase shunt coils

b) the connection system for achieving the isolated neutral of the star connection of the three coils

c) one enclosure made of light non-ferromagnetic material (thermopane glass type), with a resistance structure conceived so as no short-circuited turns to be formed. The enclosure protection degree is IP 54

The coils are optimally dimensioned, so as at rated load to consume a minimum active power, and for that reason the consumption of copper conductor is conditioned by the magnitude of the rated value of the imposed active losses and, consequently, the cost price of the product is a linear function related to this parameter. As a result, a relatively low value of the imposed active losses involves a high consumption of copper and a relatively high cost price. The technical characteristics are in accordance with the provisions of IEC 60076-6:2007.



The shunt reactor is made in single-phase design, indoor type, dry, without magnetic core, with F insulation class copper windings, with natural cooling in air.
The coil is made of many elementary coils, concentrically arranged on an insulating cylinder and is clamped and tightened by means of some insulating rods and two polygonal insulating racks located at its ends. The straining of these insulating rods is done by uniformly clamping the assembling elements by a pre-determined torque.

Technical parameters for a 20 kV, 175 kVAr single phase shunt coil

- Line rated voltage: 20 kV
- Phase voltage (equal with the voltage at the coil terminals): $\frac{20}{\sqrt{3}}$
- Rated current: 15,15 A
- Rated frequency: 50 Hz
- Rated reactance: 762 Ω
- Rated inductance: 2425 mH
- Ohmic resistance (measured in DC at 20°C): 7,5 Ω
- Active power at 20°C, rated load: 3 kW
- Reactive single phase power: 175 kVAr
- Power frequency test voltage: 50 kV_{ef}
- Lightning test voltage: 125 kV_{max}
- Overall dimensions of the coil:
    - Outside diameter of the winding: max. 1200 mm
    - Coil height, the post insulators exclusively: max. 850 mm

3. Information necessary for ordering

Based on firm order, different sizes of coils may be delivered, having the rated parameters within the range:

- line rated voltages [V]: 400 … 20000
- rated currents [A]: 10 … 1600
- rated frequency [Hz]: 50 (60)

For defining correctly the product, the customer should specify in his order the following mandatory technical parameters:

- Line voltage of the three phase network „U”
- Service voltage (at coil terminals) „U_b”
- Rated power factor (after compensation)
- Rated frequency
- The capacitive reactive power measured for the three-phase (single-phase) line, no-load operating at the service voltage existing at the moment when the measurement is performed. If this parameter cannot be measured, the following should be specified: type of the single-phase or three-phase cable; layout in delta or in line; cable length; specific capacitance; no load current of the cable;
- * Single phase active power at 20^0C, rated voltage: $P_{N20} = R_N \cdot I_N^2$, where R_N is the value of the ohmic resistance of the coil measured in DC at the environment temperature of 20^0C
- The arrangement mode of the set of three identical coils in enclosure: line layout or layout in the corner of an equilateral triangle
- **Overall dimensions of the enclosure

* The technical parameter „P_{N20}” is not mandatory; if the value of this parameter is not imposed, then the product will be sized for a value of these losses correlated with the „F” insulation class of the winding.

** If the overall dimensions of the enclosure are not imposed, then they will result implicitly depending on the value of the outside diameter of the single-phase coil „D”. Between the coil axes the minimum size will be of $2.2 \cdot D$, and between the ends of the winding and the ferromagnetic parts existing in the enclosure structure it will be of $0.55 \cdot D$.