USE OF PORCELAIN LONGROD INSULATORS IN HVDC TRANSMISSION LINES

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Introduction

In HVDC transmission lines only cap-and-pin insulators of glass and porcelain have been regularly used, although these insulators present problems leading to their failure in service. Some problems emerge as an interaction between the design principle of these insulators and the characteristic features of the d.c. voltage. Countermeasures have been taken and the failure rate is reduced. However, failure of cap-and-pin insulators still occurs and the longterm performance of the countermeasure has to be kept in mind.

Longrod-type insulators have different design characteristics than those of cap-and-pin insulators and are used so far in HVDC sub-stations. These post-insulators inherently do not present problems which are prone to cap-and-pin type of insulators. Longrod insulators to be used in HVDC transmission lines have smaller core-diameter (75 - 85 mm) than that of post-insulators and would give satisfactory performance in service.

Cap-and-pin and longrod insulators

In case of cap-and-pin insulators the puncture distance "a" is much shorter than the flashover distance "b" (Figure 1) whereas longrod insulators are characterized by almost equal puncture and flashover distance (Figure 2) and, therefore, are non-puncturable.

The pin of cap-and-pin type of insulators has relatively small diameter leading to high voltage stress enhancing the risk of electrolytic corrosion. The countermeasure of zinc sleeve has reduced this risk, has however, still to be studied with respect to life-time problems.

In case of longrod insulators the link between several insulators of the chain may show also a small diameter, but is electrically shielded by the arc protection-ring of much larger diameter, thus causing no corrosion (Figure 4 and 5).

Longrod insulators do not know any shattering of sheds in contradiction to glass cap-and-pin insulators.

In HVDC systems the short circuit current is generally of the order of only 2 - 6 kA as compared to 20 - 40 kA in equivalent AC systems. The clearance time of short circuit arcs in HVDC systems can be as low as 20 - 30 ms as compared to a few hundred milliseconds in AC systems. There is, therefore, no risk of any damage to longrod insulators by the short circuit arc.

Longrod insulators, therefore, will need much less testing and several tests related to shattering of sheds, corrosion etc. will not be necessary [3].

With respect to failures of cap-and-pin insulators under discussion, longrod insulator is a better solution and should be considered seriously for application in HVDC transmission lines.

The criteria for mechanical strength of insulators are independent of the type of voltage, i.e. ac or dc. The longrod insulators have been used in a.c. transmission lines for several tenth of years in Germany, Switzerland, Austria, Sweden, Arabian countries, South Africa etc., so that the technology for using these insulators in transmission lines is well established.

Post-insulators based on longrod-principle and used in sub-stations are subjected to pollution flashovers due to their bigger core-diameter. Longrod insulators to be used in transmission lines will have a much smaller core diameter of only 75 - 85 mm and show satisfactory pollution performance. This is illustrated in Figure 3. A reduction in core diameter from 550 mm to 170 mm raises the withstand degree of pollution from 0,01 mg/cm^2 to 0,06 mg/cm^2.

Including also pollution performance of insulators, there is no technical argument against the use of longrod insulators in HVDC transmission lines.

References

[1] Verma M. P.:
Insulation performance of dc apparatus-housing under pollution. etz-Archiv Bd. 5 (1983) H. 9

[2] Kawamura T., Seta T., Nagai K., Naito K.:
DC pollution performance of insulators. CIGRE-Report 33-10, 1984, Paris

[3] IEC 36B (SC) 121, June 1993:
Insulators for overhead lines with a nominal voltage greater than 1000 V. String insulator units of ceramic material or glass for d.c. systems. Definitions, test methods and acceptance criteria.

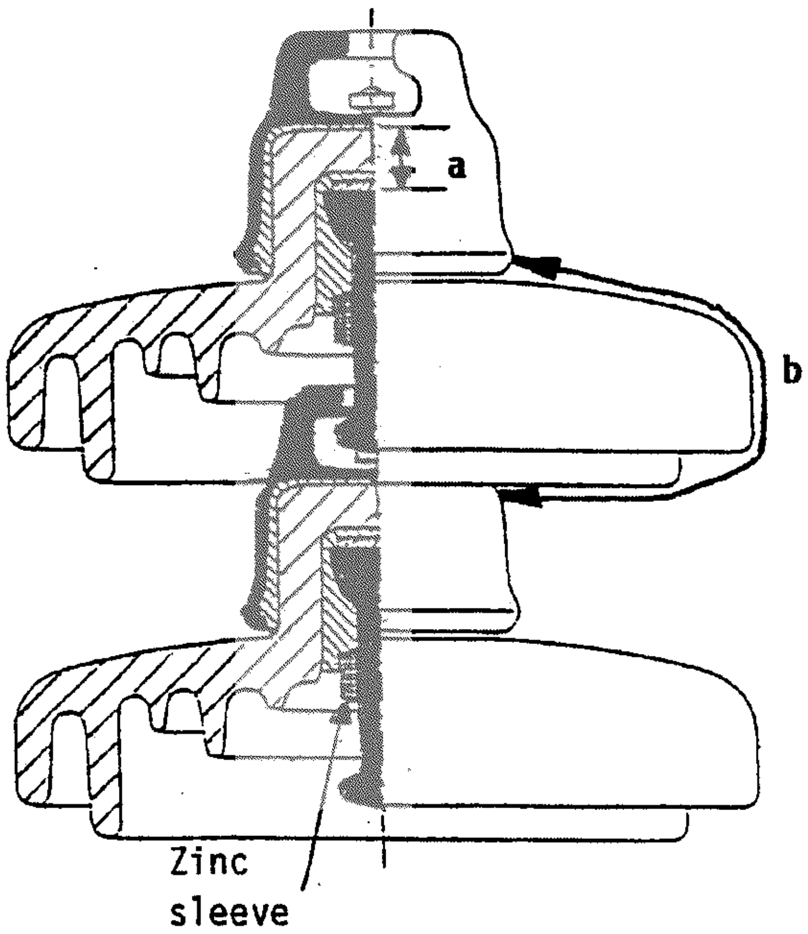


Figure 1

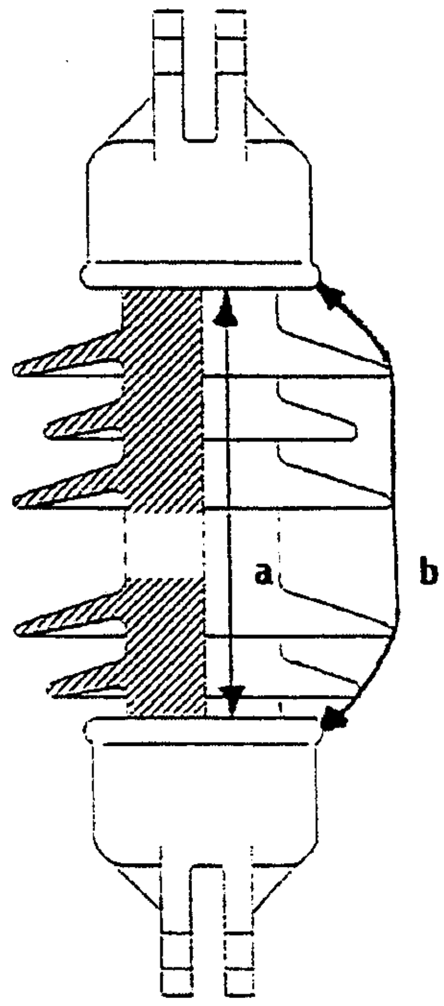
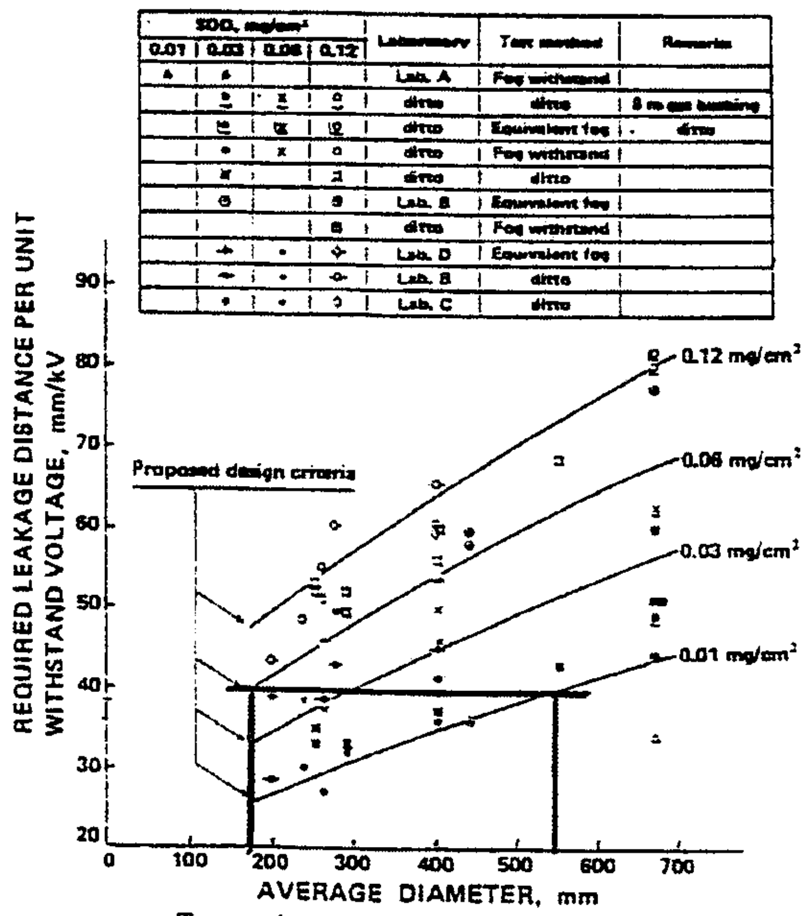


Figure 2



Test results at various laboratories and an example of pollution design criteria for porcelain housings

Figure 3 [2]

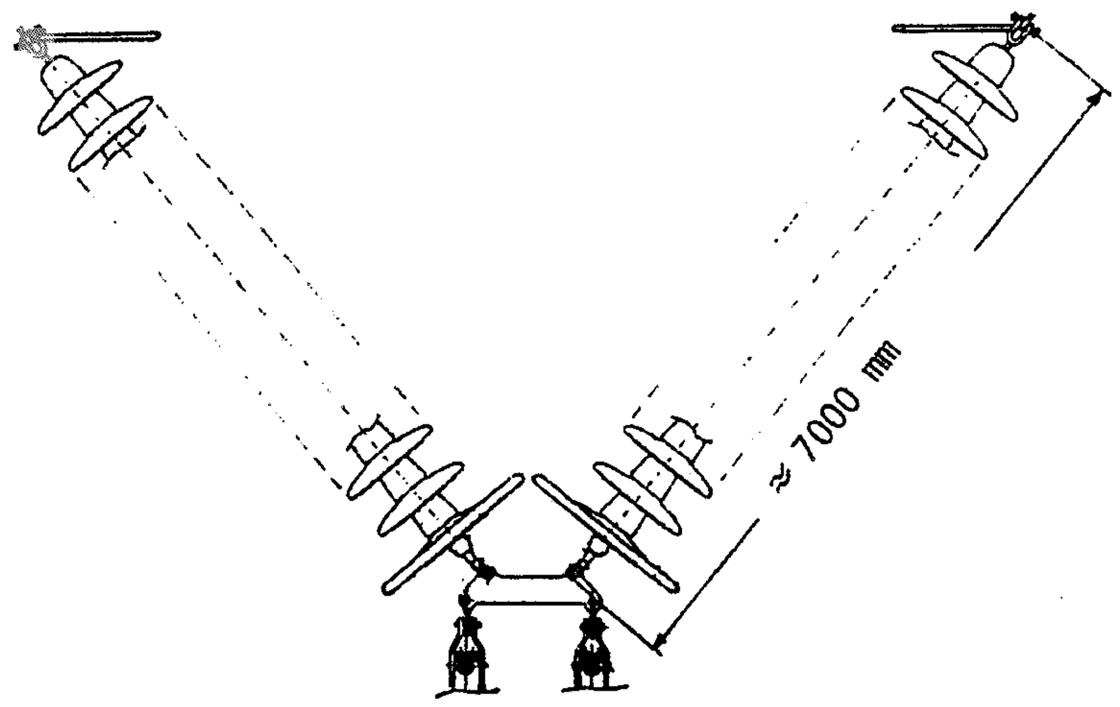


Figure 4

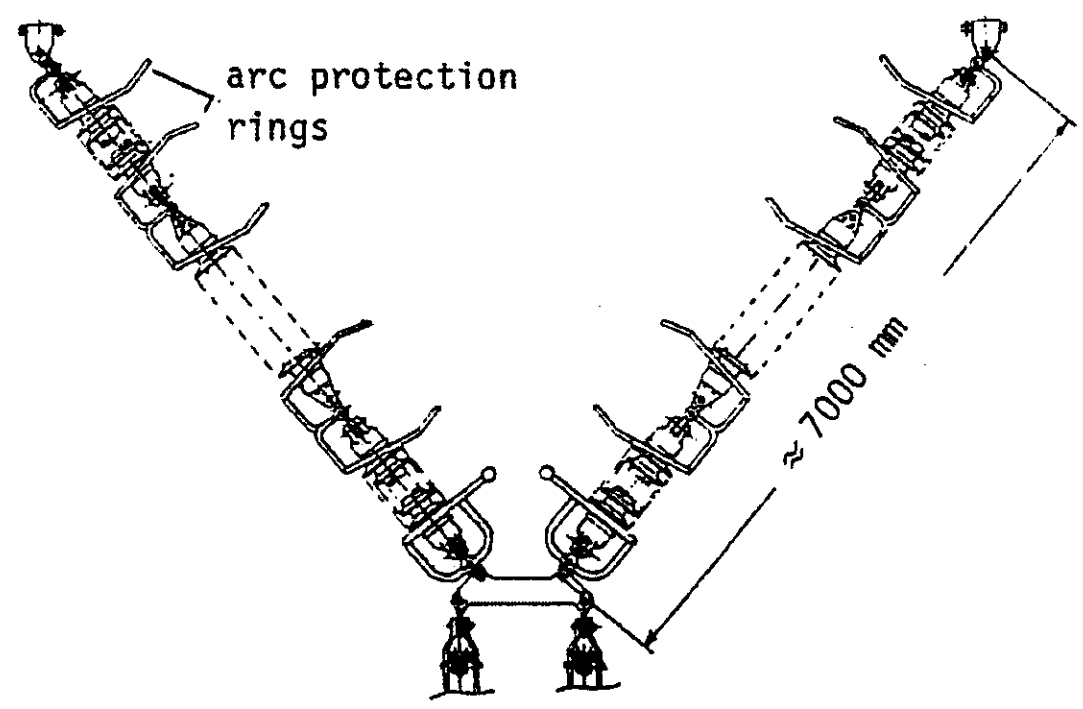


Figure 5

500 kV HVDC insulator chains