Conceptual Design of a Single Phase 33 MVA HTS Transformer with a Tertiary Winding

S. W. Lee*, W. S. Kim[+], S. Y. Hahn[a], Y. I. Hwang[b], K. D. Choi[b]

[a] *Korea Electrical Engineering & Science Research Institute, Seoul, Korea*

[b] *Korea Polytechnic University, Shiheung, Korea*

High Temperature Superconducting (HTS) transformers have many benefits over the conventional transformers. The HTS transformer has higher efficiency, smaller size, lighter weight and environmentally friendly characteristics than the conventional oil transformer does. The size effect of the HTS transformer is the most important merit in Korea. The standard of power capacity of the 3 phase transformer for 154 kV power line is 60 MVA. The reason for it is mainly because of the size and weight of the transformer. If the HTS transformer substitutes for the conventional one, its size might become 1/3 or 1/2 of the conventional one. Though it is not a so critical benefit for the substations which are built on the field or in the mountain far away from metropolis, but there are about 50 under-ground substations at the basements of large buildings in Seoul. There is no way to increase the power capacity of the substations in Seoul except constructing new buildings.

We have proposed 100 MVA, 3 phase, 154 kV class HTS transformer substituting for 60 MVA conventional transformer. The power transformer of 154 kV class has a tertiary winding besides primary and secondary windings. So the HTS transformer should have the 3rd superconducting winding, it makes the cost of the HTS transformer high and the efficiency low. In this paper, we designed conceptually the structure of the superconducting windings of a single phase 33 MVA transformer. The electrical characteristics of the HTS transformer such as % impedance and AC loss vary with the arrangement of the windings and gaps between windings. We analyzed the effects of the winding parameters, evaluated the cost of each design, and proposed a suitable HTS transformer model for future power distribution system.

keywords: High Temperature Superconductivity, Transformer, Tertiary Winding, AC loss