Surge Arresters for Gas Insulated Switchgear (GIS)

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Abstract

Until the mid-1990s, we had been realizing the compact design of surge arresters for Gas Insulated Switchgear (GIS) with a three-column structure design electrically connected in series. Since then, we realized a simple and compact surge arrester design through the development of high gradient blocks.

There are many Metal Oxide (MO) block suppliers in the world, however, only a few suppliers can produce high gradient blocks. Such blocks are essential in making compact and light-weight surge arrester units.

Currently, we are manufacturing and selling a variety of surge arresters, both units with high gradient blocks and surge arresters (tank type) for GIS. More than 20,000 of surge arrester units have been delivered at home and abroad.

1 Preface

Surge arresters are used to protect electric equipment such as power transformers and switchgears against an overvoltage in power network systems. Surge arresters play an important role in maintaining a stable power supply. Metal Oxide (MO) surge arresters are currently the mainstream in the field of surge arresters used in power network systems worldwide. We developed and commercialized such an MO surge arrester without series gaps for the first time in the world. The MO surge arrester employs MO blocks. It demonstrates excellent non-linear voltage-current (V-I) characteristics.

With the advent of the MO surge arrester, power outage incidents caused by overvoltage, like lightning strikes, are drastically reduced. In addition, since overvoltages can be suppressed by the excellent non-linear V-I characteristics, it is possible to have a lower level insulation design for power network systems. As a result, substation equipment can be a compact design with big economic benefits.

Meanwhile, the Gas Insulated Switchgear (GIS) is increasing because it can operate with a smaller footprint (compact space) than a conventional air-insulated substation. This paper introduces the surge arresters for GIS (GIS surge arrester).

2 History of Meiden GIS Surge Arresters

In 1975, we developed and commercialized the world's first porcelain-housing type MO surge arrester without series gaps. One year later, we developed and released GIS surge arresters. In 1979, the Japan's first 500kV GIS surge arresters were developed and delivered.

In the early days, our GIS surge arrester was produced in a single-column structure. This unit was, however, subject to increasing the total length when the rated voltage became higher. As a result, we developed a design of a three-column structure system where the conducting pass is connected in series. Fig.1 shows a conducting pass and external appearance of the arrester unit in the three-column structure.

In this case, however, this three-column structure has an intricate internal construction compared with the single-column structure. To resolve this issue, we embarked on the development of high gradient blocks.

3 Development of High Gradient Blocks

The high gradient block has a high reference voltage per thickness. For this reason, it is possible
to decrease the number of blocks and design a compact surge arrester. Fig. 2 shows image of block use between conventional blocks and the high gradient blocks.

The MO block is composed of ZnO grains of about 10μm and grain boundary layers that surround ZnO grains. The reference voltage of the MO block is in proportion to the number of grain boundary layers between electrodes of both ends. Accordingly, to get a high gradient to the block, it is necessary to reduce the ZnO grain size and increase the number of grain boundary layers.

To obtain high gradient blocks, we improved the composition compound and sintering processes as described below.

(1) Composition compound
Selection of materials and its optimum composition compound of materials

(2) Sintering
Suppression of grain growth and control of grain boundary layers

As the number of grain boundaries increases as the ZnO grains are miniaturized, the resistance of the element can be increased.

In order to increase the energy withstand capability, we analyzed the breakdown mode and primarily improved the side insulation.

As a result of these improvements, we finally developed high gradient blocks with high reliability.

There are many companies that manufacture MO blocks globally. But most of them only produce conventional blocks. To develop high gradient blocks, it is necessary to have high technologies such as suppression of grain growth, advanced control of grain boundary layers, improvement of energy withstand capability, and technologies for the reinforcement of side insulation. For this reason, there are few companies that can manufacture high gradient MO blocks.

Table 1 shows a comparison of arrester units for 500kV systems between the three-column structure with conventional blocks and a single-column
structure with high gradient blocks. Due to the high gradient blocks, the number of blocks used has been reduced by 50%, and this has resulted in the simplification of structures, a decrease in the number of parts used, and a reduction of total mass to about 70%.

4 Introduction of Meiden GIS Surge Arresters

We manufacture GIS surge arresters at our SORESTER Factory in Japan and MEIDEN ZHENGZHOU ELECTRIC CO. LTD. (MZE) in China.

4.1 GIS Surge Arresters Manufactured by MEIDEN for Japanese Market

Table 2 shows the major ratings of the ZS-D Series delivered to the Japanese market. This series involves surge arrester units in a single-column structure with high gradient blocks covering up to the rated voltage of 280kV (power system voltage 275kV). Some are used as a built-in unit for Meiden switchgears and are also delivered to GIS manufacturers in Japan. Surge arrester units equipped with disconnecting devices are also released so that the arrester unit can be disconnected from a power network system during withstand voltage test at the site. Since the release in 1998, we have delivered more than 4000 units of ZS-D series surge arresters in Japan.

4.2 GIS Surge Arresters Manufactured by MEIDEN for Overseas Markets

For overseas versions of our product, we manufacture a series of surge arrester units with the rated voltages of 60kV to 468kV in accordance with IEC 60099-4. Table 3 shows the major ratings of GIS surge arrester units for overseas markets. These surge arrester employ higher gradient blocks compared to Japanese market. Since the release in 2011, we delivered more than 1000 units of ZSE-G Series surge arresters.
MZE in China began to manufacture high gradient blocks early on and developed the tank type GIS surge arresters in accordance with the IEC Standards and GB Standards – (China National Standards). These products are designed to realize the compact and light-weight surge arrester.

Fig. 5 shows a GIS surge arrester for the 500kV system, Fig. 6 shows GIS surge arresters for the 220kV and 110kV systems, and Fig. 7 shows a GIS surge arrester for the 150kV system. Regarding the supply records, 37 pieces (single-phase type) for the 500kV system, 4400 pieces (single-phase type) for the 220kV, and 3500 pieces (three-phase type) for the 110kV system (total surge arrester 10,500 units) have been delivered.

5 Postscript

This paper introduced a history and the features of Meiden GIS surge arresters with high gradient blocks. It realized a remarkable compact design in size and mass.

We will continue to make every effort to realize higher gradient for the arrester blocks so that GIS surge arresters can become more compact to reduce environmental impact.

We will also realize the compact design in our line-ups of all type such as porcelain housing and polymer housing type surge arresters. In so doing, we will continue to offer a wide variety of compact surge arresters for markets worldwide, contribute to the safety and stability of power facilities, and work towards global environmental conservation.

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