APPLICATION OF 6-750 kV SURGE ARRESTERS FOR POWER NETWORKS

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Introduction

At present, when the majority of gapped surge arresters (GA) located in power systems have exhausted their resource, and their release is practically discontinued, the issue of replacing arresters with nonlinear metal oxide surge arresters (MOA) is particularly relevant. In addition, there is a great need for MOA not only at existing facilities, but also at those under construction. Naturally, designing and operating organizations have numerous questions about the use of MOA. Among others, an important place is occupied by the issues of choosing MOA characteristics.

If there were several main types of GA, which was quite convenient, then at present the manufacturers of MOA offer the widest range of products, giving rise to the well-known problem of choosing MOA.

Russia has already accumulated considerable experience in the use of MOA. It would seem that it is enough to compare the results of scientific research and calculations of the required characteristics with the subsequent operating experience of the selected MOA, make the necessary corrections to the calculation programs and it will be possible to develop an exact method for MOA selecting. However, already at the stage of collecting information about the operational experience, there are significant difficulties. The fact is that neither power systems nor MOA manufacturers are in a hurry to share information about the number and conditions under which damage occurred to the MOA themselves and the equipment they protect.

To a certain extent, the experience of using MOA and the results of scientific research is reflected in well-known brochures in Russia [1,2]. Although these brochures were approved by the biggest network operator J.S.C. "Russian electrical networks", they did not receive the status of a regulatory document, i.e. mandatory for application, and they have the nature of a recommendation. The only normative document is [3], but its use is difficult due to the often-excessive details in the description of complex processes under transients and overvoltages. Methods of choosing MOA, which are offered by manufacturers MOA, in the vast majority of cases, are more or less complete a copy of [1,2], much less often they rely on data [3].

The guidelines [1,2] and norms [3] have been published for a long time ago, and the scientific community has already commented on these documents (see, for example, [4,5]). Without going into a discussion about the fairness or unfairness of such remarks, it should be noted: despite the fact that the authors [1,2] and [3] made efforts to simplify the method of choosing an MOA, it is still quite complex both for designers and for operation. The way out of this situation is seen in a different approach to the construction of the methodology.

It should be understood that simple calculations are possible mainly in schemes that are reduced to one-line ("one phase" instead of three). At the same time, it is known [6-7] that, for example, processes during a single-phase arc earth fault in 6-35 kV networks with an isolated neutral or, for example, ferroresonance processes cannot in principle be correctly considered in a single-line formulation. A reliable analysis of the effects on the MOA in these and some other cases are possible only in a three-phase formulation, i.e. mainly using detailed computer modeling, and even better – with field experiments in the real power system. So, in general, it is not correct to develop a simplified methodology for choosing an MOA due to objective reasons.

Many years of experience in carrying out calculations on the choice of MOA in various power supply schemes shows that the characteristics required for the protection of equipment usually vary within small limits. Therefore, calculations of MOA it is advisable to carry only when there is a chance of encountering the case of the need to use an MOA with characteristics markedly different from the "typical" ones.

In special cases, of which there are objectively a few in the networks, it turns out to be technically and economically justified to carry out calculations using special computer programs (EMTP, MATLAB, PSCAD, etc.), which allow modeling processes in networks and assessing the impact on equipment and MOA. Since there are few special cases, one should not resort to any serious simplifications in these calculations. In typical cases, on the contrary, there is no need to carry out any calculations, since the use of both complete and simplified methods will give a previously known the result is typical characteristics of the MOA.

The proposed ideology of MOA selection is very attractive, since it requires calculations of MOA characteristics only in exceptional (special) cases, which most power engineers do not encounter. In addition to the general ideology of MOA selection, it is necessary to determine which characteristics of the MOA actually needs to be chosen.

The list of MOA parameters given in the manufacturers' catalogs is more than solid: there is both the highest operating voltage of the MOA and the rated voltage of the MOA (it is close in meaning to a similar parameter used for gapped arresters, and fundamentally differs from widely used nominal voltage of the equipment that everybody knows). Also, there are the energy absorption capability and the residual voltages on impulse currents of various wave shapes. What is written in the MOA catalogs is, in fact, a list [8] of the results of MOA tests, but most power engineers do not need such detailed information. Therefore, to a certain extent, the question arises as to which among the numerous characteristics of the MOA are the main ones and deserve the main attention, and which are secondary, largely dependent on the main ones.

The design of the MOA is very simple – it is based on a column of nonlinear resistances (varistors), which has only two geometric characteristics – the height of the column and its diameter. It turns out that many characteristics of modern MOA of various manufacturers are related to each other and are determined by its highest operating voltage (depends on the height of the varistor column) and energy absorption capability (depends on the outer diameter of the varistor column). Therefore, it is necessary to pay attention, first of all, to these two values.

So, the approach to the choice of MOA proposed and implemented in the Book is based on the following:

- cases of the use of MOA should be divided into typical and special;
- in special cases, the characteristics of the MOA are determined by the results of detailed computer modeling;
- in other cases, not related to special ones, there is no need to carry out calculations, and the characteristics of the MOA are accepted as standard;
- among the many electrical characteristics of the MOA listed in the manufacturers' catalogs, the most important are the highest operating voltage of the MOA and its energy absorption capability; the remaining characteristics of the MOA are subject to verification to meet the operating conditions only in special cases.