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Pipe-type cables : retrofitting and ampacity

ARGAUT, P., LESUR F., SAGEM SA, Montereau, France

Résumé

La reconfiguration des réseaux de câbles en tuyaux d'acier est un problème technique intéressant. Les tuyaux existants peuvent rester en place, seules les phases doivent être remplacées par tirage. Cet article propose d'étudier dans quelle mesure des conducteurs sous isolation synthétique peuvent constituer une alternative aux anciens câbles isolés au papier imprégné. En raison d'impératifs liés au dimensionnement en champ électrique, le diamètre externe des câbles extrudés peut s'avérer plus important que celui des câbles à papier imprégné, et un tel remplacement devient parfois irréalisable.
Après des rappels de calculs propres aux câbles en tuyaux d'acier, quelques études comparatives montrent l'influence du changement de technologie.

Abstract

Retrofitting of pipe-type cables systems is an interesting technological challenge. Existing steel pipes can stay on site, only the conductors have to be changed by pulling. The scope of work of this paper is to study how conductors with extruded dielectric insulation can replace the old oil-impregnated paper tapes conductors.
Due to electrical stress design considerations, the outer diameter of extruded cables may be larger than for the previous oil-impregnated cables, and such a substitution becomes sometimes unfeasible.
After notes about calculations, characteristic of pipe-type cables, some comparative studies show the influence of the technological modification.

1. Pipe-type cables

Pipe-type cables are the most commonly used in the United States for transmitting power at high voltages. Three phase conductors are insulated with layers of oil-impregnated paper and housed in a coated steel pipe. The free area in the pipe is pressurised with a dielectric fluid (oil or gas filled) to increase the dielectric strength of the system, to suppress ionisation in the insulation, and to defer moisture ingress in the event of a leak in the pipe.

This mode of installation offers several advantages : the pipe itself is very tough and can be installed with short and narrow roadway openings, minimising traffic disturbances. When the pipe sections are welded together, the cables may be pulled at a later date, and the maintenance requirements are low compared with self-contained fluid-filled cables.

2. Underground systems retrofitting

The first pipe-type cable system was installed as far back as 1932. Retrofitting of systems is planned, and steel pipes are very suitable for the replacement of old insulated conductors or to increase the cable size. Existing pipes can stay on site, only the conductors have to be changed by pulling.

By adopting another technology, utilities reduce their environmental exposure to oil leaks. An idea is to replace the old oil-impregnated paper tapes conductors by conductors with extruded dielectric insulation such as polyethylene. Due to electrical stress design considerations, the outer diameter of extruded cables may be larger than for the previous oil-impregnated cables. Therefore, the substitution is not always feasible because of the minimum clearance between the top of the upper cable and the pipe.

With extruded cables designed with a moisture barrier as a thin metallic sheath, no pressurised dielectric fluid is required. The technological change affects cable ratings because insulation and the free area in the pipe are modified.

The electrical stress design is the first element to design extruded cables to be pulled in place of existing insulated conductors in steel pipes. A second design point of view concerns ampacities and is of great interest. It rules the performance and the final acceptance of the proposed new solution.