GIL FOR POWER TRANSMISSION IN SPECIFIC SITE CONDITIONS

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ABSTRACT

Gas Insulated Lines, developed in the late 1960s, are a transmission technology with high power ratings and very low power losses used in different arrangements in high voltage substations.

When installed outdoor, the effect of solar radiation has a strong impact on GIL temperature rise and, therefore, on rating and overload performances.

Tunnel installations, like in hydro power plant cavern, have an influence temperature rise of GIL too.

The paper develops how theoretical calculations and studies, coupled to in-condition real testing and monitoring are the best way to ensure GIL performances whatever the installation conditions.

KEYWORDS

GIL, solar radiation, overload, tunnel installation, monitoring

INTRODUCTION

Energy needs are constantly increasing worldwide. Utilities need to reinforce their network and this is usually achieved through power capacity increases and connections to new energy sources. As a consequence, electrical transmission for high energy loads has to be developed and suited to each specific site conditions.

The high transmission capacity of GIL (up to 3000 MVA through one circuit) and its multiple achievable configurations offer important advantages for transmitting bulk electric power in complex sites and with different ambient conditions, like crowded substation, hydro power plants, underground facilities, etc. GIL is well suited for connections between two GIS substations, GIS and a transformer or to an over-head line.

The different ambient conditions encountered in these locations can influence the temperature rise of the GIL and therefore its rating. Among them are the solar radiation effect and the tunnel installation (horizontal and vertical).

Monitoring of is also a key issue to ensure the global performances of the GIL.

The paper will review in more details these different aspects.

SUN RADIATION INFLUENCE

The GIL installation can take different ways: above the ground (most of the cases), in trenches or in tunnels. Each of these configurations will influence the thermal limits of the product for the same rated current.

In the case of outdoor installation, effect of solar radiation in highly exposed countries has a major impact on GIL temperature rise and, as a consequence, on performances in terms of ratings and acceptable overloads.

In order to understand the influence of sun radiation on heat transfer characteristics of GILs, temperature rise tests without injected current have been performed on horizontal GIL units installed outdoor under natural weather conditions and results have been compared with thermal simulations.

Test objects and results

The two separated test objects are composed by a straight, closed GIL compartment of 2.5m length filled with ambient air. Dimensions and characteristics are shown in Table 1. The external enclosure surfaces of the two compartments are respectively aluminium without paint (compartment A) and aluminium with white paint (compartment B).

Table 1: GIL characteristics

	Bar	Enclosure
External diameter [mm]	190	560
Thickness [mm]	12	10
Aluminum Material	EN AW-6101B	EN AW-5083
Resistivity [Ω·mm²/m]	0.03125	0.0550
Temperature coefficient [1/K]	0.004	0.004
Density [Kg/m^3]	2700	2670
Conductivity [W/(m·K)]	180	132

To represent the real site enclosure surface conditions, the compartments were placed outside for several months without specific cleaning the surfaces. The radiation emissivity ε (related to a 343K dark body spectrum) and the radiation solar absorption α (related to the solar spectrum) of enclosure surface are hence influenced by air pollution and aluminium oxidation. Before the test the radiation coefficients have been measured experimentally in specialized laboratories and the obtained results are listed in Table 2.