

Installation of Twenty-four (24) Lines of 150kV XLPE Power Cables at 2.5 m Depth below Ground Level in the Tropical Urban City: Jakarta

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ABSTRACT

Jakarta as the capital city of Indonesia, since 2010 has issued new rules about Network Utilities Placement Procedure, one of its contents about guidelines for the installation of high-voltage cables. This law stated that the high voltage cables should be buried at a depth of 2.5 m from the ground level to the top surface of the cable

In order to connect the substation (150 kV Tanah Tinggi Substation), required incomer transmission with double-phi configuration (4 circuit) with the number of cables per phase is two (2), so the total number of cable are twenty-four (24) cables. All the cables used XLPE insulation, the first and second circuit used 1000 sqmm copper conductor and for third and four circuits, used 800 sqmm copper conductor.

With the numbers of cables to install, and consider Jakarta as a crowded city in Indonesia, problems arise due to the rules above and also social and environmental issues. This makes some the limitations of the location, where only allows installing over the highway, crowded street and crossing the river.

We try to made calculation and simulation using COMSOL for the thermal resistance and ampacity of the circuit for this installation, but until the deadline it's not finish. So this paper only covers the installation details.

Finally this transmission used two system of installation, there are open system with box-culvert construction, and boring system with concrete type and concrete pipe type. For box-culvert type, cable construction made by eight (8) rack support which each rack containing 3 cables, and for concrete type, cable construction made of six (6) cables in horizontal in four (4) stacking.

KEYWORDS

Power Cables, XLPE Cable, Power Cable Installation, Cable Ampacity, Ducts, Trench.

INTRODUCTION

Cable is one of the power transmission media on high voltage and low voltage, in addition to overhead line (OHL) conductor. Cables can be installed using duct, tunnel or pipes, we called closed type, and by direct buried method we called open type. In several big cities of developed countries, high-voltage cable transmission lines have been used through the tunnel. The tunnel is in addition to the power system; also used for other utilities such as telecommunications, water installation etc, while in developing countries such as Indonesia, high-voltage cables installation usually used direct buried.

There are different characteristic for each type of installation above. Open model have more problem than closed type, such as influence of ambient and limit for upgrade the system, but the benefits is more cheaper than closed type. So for developing countries, closed type

stills an option.

Jakarta as the capital city of Indonesia, since 2010 the government has issued new rules about Network Utilities Placement Procedure, one of its contents sets out about guidelines for the installation of high-voltage cables. This law stated that the high voltage cables should be buried at a depth of 2.5 m from the ground level to the top surface of the cable. It means that the depth of trench is more than 2.5 m depending on the number of cables. This is different from a common design that has been used in Indonesia, which high-voltage underground cables are usually buried with trench depth up to 2.5 m. With the new rules, it is necessary to re-design the method of high-voltage underground cables installation in Jakarta.

THEORY AND REVIEWS

Ampacity and Temperature

As the purpose of underground cables for power transmission, the first consideration is the current-carrying capacity of the cables or also called ampacity. In physical, in addition to electrical resistance of the conductor, ampacity also strongly influenced by the temperature, which by Neher and McGrath [1] described the relation of ampacity and other factors such as the equation (1).

$$I = \sqrt{\frac{T_c - (T_a + \Delta T_d)}{R_{dc}(1 + Y_c)R_{ca}}} \quad (1)$$

In this formula, ampacity depends on the temperature of conductor (T_c), ambient temperature (T_a), temperature of conductor due to dielectric loss, electrical resistance (R_{dc}) and thermal resistance of the circuit (R_{ca}). With conductor temperature and ambient temperature are not controllable then the best way to manage the ampacity is to control the thermal resistance.

Thermal Resistance

Since Neher-McGrath equation developed, several researchers (as authors reviews) were applied and developed the equation then make the topic to found the best approach of ampacity calculation in the field.

M.A. Kellow [2] calculating the temperature rise and ampacity ampacity of underground cables by numerical procedure, with the point is to calculate the heat dissipation from a distribution duct bank. By numerical procedure, M. A. Kellow stated that the analytical procedure of Neher-McGrath is inaccurate especially in the case of a multi-cable duct bank installation.

M.A. El-Kady [3] also makes some calculation with objective to optimization of power cable and thermal backfill configurations. These calculations affirm about influence of backfill material to cable ampacity.