

Study on Influence of UHVDC Transmission Lines on the Adjacent Metal Pipelines

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Abstract

DC transmission, which has the advantage of long distance and large capacity, become the trend of the development of the power grid in China. In this paper, the development of UHVDC has been introduced. Influence of UHVDC transmission lines on the adjacent metal pipelines has been discussed. In the end, combining with the situation of China, it is necessary to pay more attention to the influence of UHVDC Transmission Lines.

Keywords

UHVDC, Metal Pipelines, Electromagnetic Influence.

1. Introduction

With the rapidly development of economy and the growing demand for electricity, State Grid Corporation of China will invest a lot of capital construction of UHVDC power grids. Meanwhile, the construction of oil pipelines is also growing rapidly. Due to the electric power industry and oil-gas industry for the preferential principle of transfer path is very similar, sometimes there will have a situation that transmission line and pipelines parallel close to or crossing cross. Analysis of UHVDC transmission line of adjacent oil-gas pipelines caused by the electromagnetic influence, ensure metal oil-gas pipelines system and personnel safety ^[1].

2. The Development of UHVDC Transmission Technology

In order to meet the needs of long and large capacity transmission, The United States, Italy, Brazil and other countries have begun the research of UHV transmission technology in the 1960s, and have made great progress. $\pm 800\text{kV}$ belongs to a new voltage grade, in order to get the public to accept, economic and reasonable transmission line design, it needs a large number of experimental studies. $\pm 800\text{kV}$ and more than $\pm 800\text{kV}$ UHVDC transmission line will have a series of electromagnetic environment caused by corona phenomenon and electric field effect ^[2,3]. Such as audibility noise, radio interference and electric field effects on the ecological impact, etc. CIGRE organizes expert working group to evaluate the UHV technology, the result shows us that the practical application of UHVDC transmission technology has been mature ^[4].

HVDC technology research relatively late in our country, until 1986 we began to study on the early stage of the UHV transmission problem. Gezhouba – Shanghai $\pm 500\text{ kV}$ DC transmission line is the first DC power transmission project in China, then China's relevant departments combined with G-S DC project to carried out a research on the design of DC transmission line ^[5]. But along with the DC transmission voltage level unceasing enhancement, there is a certain difference between $\pm 500\text{kV}$ DC and $\pm 800\text{kV}$ UHVDC transmission project . Whether the electromagnetic environment problems of $\pm 800\text{kV}$ UHVDC can be directly applied the standards of $\pm 500\text{kV}$ DC, it remains to be further research. In recent years, in projects funded by state grid corporation, EPRI of China, North China Electric Power University (NCEPU), STATE GRID have carried out research work, which is about $\pm 800\text{kV}$ DC transmission line electromagnetic influence on oil gas pipeline.

3. The Research Status of UHVDC Transmission Interference on Adjacent Pipelines

At present most of the research is aimed at the influence of UHV AC transmission line on the adjacent pipes. But the impact of DC transmission lines are different from on the AC transmission lines, many research results are no longer applicable. Along with our country developing UHVDC grid, due to the restriction of supply and demand, transmission line and oil-gas pipelines are often parallel close to or crossing cross. So we need to study whether UHVDC transmission lines have any influence on personal safety, pipe security and pipeline cathodic protection equipment, etc.

Elsyca is a Belgium company who has 30-year history in simulation of data and project practice, it focuses on the research on negative protection data simulation and high voltage transmission circuits of pipe disturbance. The company itself invited a software for simulating protection of negative, named CPmaster, and a software for disturbing high alternating voltage transmission circuits, named CatProAC. Recent years, with the increasing number of pipes and high voltage circuits crossing and parallel, the researches on influence of direct current transmission circuits for near metal pipes have paid more attention [6].

4. The Influence of UHV Transmission Lines on the Adjacent Pipelines

UHV transmission lines normally work as dual-pole-metal loops, have little magnetic and electric influence with near metal oil-gas transportation pipes system. If direct current circuit worked in an abnormal condition shortly, or had an earthing short-circuit fault, the DC line will work as single unipolar-earth loop model, at this time, HVDC/UHVDC transmission lines will influence the oil-gas transportation pipes system in the under two aspects:

Stable state.

Direct current go to earth through grounding electrode, change the electric potential around grounding electrode, and influence the electric potential system of underground pipe system. The change will make the metal oil-gas pipe transportation anti-corrosion system invalid.

Transient state.

When the unipolar earthing short-circuit fault of the HVDC/UHVDC transmission line has happened, because of direct current circuit has many electric emotional equipment, at the same time, circuits have distributed capacitance with ground, from the short occurred, until the system become stable, in case inductive current don't be mutation, short current including constant amplitude period component and according index rule decreasing none period component.

When direct current transportation system is unipolar earthing short-circuit, there are many power electronic devices in both rectification and contravariant devices, in the short circuit, the distributed capacitances will make voltage almost unchanged. Short current of DC line will change from working current to fault current, fault current mostly can be 2 or 3 times compared with rated current [7]. In the end of fault current transient state, fault current waves form almost be a sine wave whose frequency is 30Hz, amplitude is rated current 1/4. Because of the feature of the unipolar earthing short-circuit fault of the UHVDC/HVDC transmission line, for this circuit, the danger happened when the short current none period component increase part in the near pipes should be considered.

Under the effect of long time voltage interference, the under ground metal pipes will be corrosion even perforated, coating may striped from pipes, metal will become hydrogen embrittlement; negative pole protection become weak, even can make it useless; if the pipes take sacrifice the positive pole protection, overhigh direct current voltage will make positive pole ability decrease, even poles changeover, accelerate the pipes corrosion, if the circuit suffer phase-line grounding, lighting, it is easy threaten people and pipes.

5. Conclusion

We need electric energy more and more with time goes on, China is developing UHVDC vigorously. At the same time, UHVDC transmission line and oil-gas transportation pipes public galleries become more and more, it is necessary in doing research about the influence and danger between UHVDC transmission line and metal pipes electromagnetism. It can provide proofs on pipe protecting and circuits setting up.

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