Investigation of Power Line Regime Parameters in Case of Switching over with Switch Gears in Electrical Networks 20 kV

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Abstract – **This paper presents the results of model research of the regime parameters (currents and voltages) in an electrical network 20 kV during operations with a switch gear of a power line without a load. The most widespread electrical distributing networks in Bulgaria are the medium voltage networks 20 kV. They have many kinds and are very branched. Some operations can be fulfilled by the switch gears. The network regime parameters change in this case.**

Keywords – **medium voltage, switch gear, overvoltages.**

I. INTRODUCTION

An uninterruptedness of the consumer's power supply depends on the operations of medium voltage power networks and on the determination the indexes for the power supply quality (CAIDI, SAIDI, SAIFI) [5], [6]. This problem is very topical in the last years.

A disconnection of the damaged part is one of methods for a decrease of the consumer's number without power supply.

The most widespread electrical distributing networks in Bulgaria are the medium voltage networks 20 kV. They have many kinds and are very branched. Some operations can be fulfilled by the switch gears. The network regime parameters change in this case.

II. IMITATION MODELS

The aim of the paper is to study the regime parameters (currents and voltages) in an electrical network 20 kV during operations with a switch gear of a power line without a load.

The following variants are studied:

1. Disconnection with a switch gear of an air power line (APL) or a cable (CPL) without a load.

The studies are made:

- for different length of the lines;
- when the voltage has a maximum or a zero value (φ=90° or φ=0°).

Figure 1 shows the power line scheme of this case.

2. Connection with a switch gear of a air power line or cable without a load on a power supply in both sides.

The imitation model of an electrical network 20 kV is used for study of the regime parameters [1]. The imitation model includes following blocks: supply system (S); power transformer 110/20 kV (PT 110/20); power line 20 kV – air or cable (W1,W2); power transformer 20/0,4 kV (PT 20/0,4) and switch gear.

The structural elements of the network have following parameters: power transformer - 110/20 kV, 63 MVA; air power line (W1, W2) conductor type AC95; cable type САХЕкТ 120; power transformer – 20/0,4 kV, 25 kVA; switch gear POM 20/200, switching possibility 25 A inductive current [2].

Control parameters for an appraisal of the processes are: phase current (I1) and voltages between the poles of the switch gear (U2). (fig. 3)

Figure 3 shows the model network scheme in case of disconnection with a switch gear of a power line without a load. The scheme is realized in MATLAB SIMULINK.

III. EXPERIMENTAL RESULTS

The studies are made for the air power line with length 5 km and 50 km. Influence of the power line length is studied over the disconnection possibility of the switch gear.

Figure 4 and Figure 5 show the results for the phase currents and the overvoltages between switch gear's poles in case of disconnection with a switch gear of an air power line without a load (length 50 km – fig. 4; length 5 km – fig. 5). The voltage has zero value (φ=0°).

Figure 6 shows the results on the same initial conditions as fig. 4 but the power transformer is switched off in a medium voltage side.

Figure 7 shows the regime parameters in case of disconnection with a switch gear of a cable power line without a load. The voltage has zero value (φ=0°).

Figure 8 and figure 9 show the dependence between capacitance current and length of air power line (for AC 50 and AC 95) and cable power line (for ОСБ 120 and САХЕkТ 185). The currents are calculated for a rated voltage 21 kV.

Figure 10 and figure 11 show the results in case of connection with a switch gear of a power line without a load

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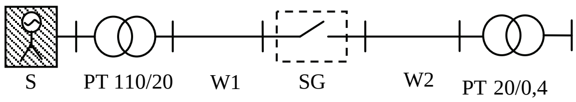

Fig. 1. Scheme of a power line (variant 1)

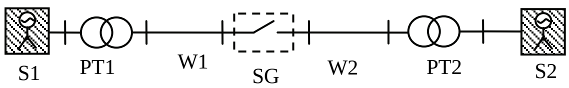

Fig. 2. Scheme of a power line (variant 2)

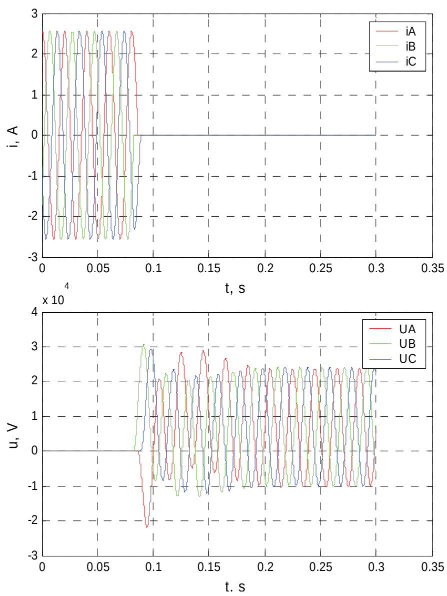

Fig. 4. Phase currents and overvoltages between switch gear’s poles in case of disconnection with a switch gear of an air power line without a load,length 50 km (φ=0°)

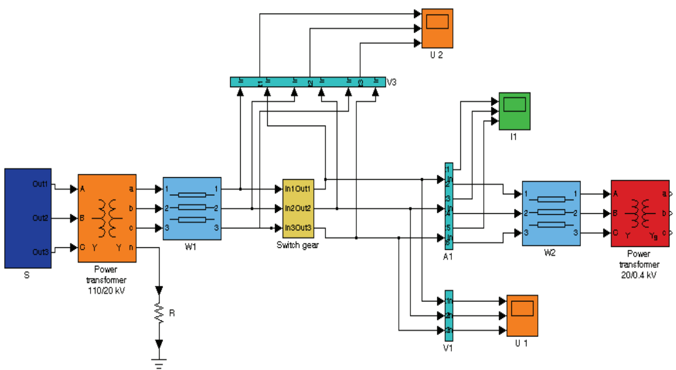

Fig. 3. Model network scheme in case of disconnection with a switch gear of a power line without a load

on a power supply in both sides. Voltage dephasing is 0° or 120°.

Figure 12 shows the results when the Voltage dephasing is 5°.

Figure 13 shows the regime parameters in case of connection with a switch gear of an air power line without a load on a power supply in both sides when the power transformer’s voltages are 19 kV and 21 kV.

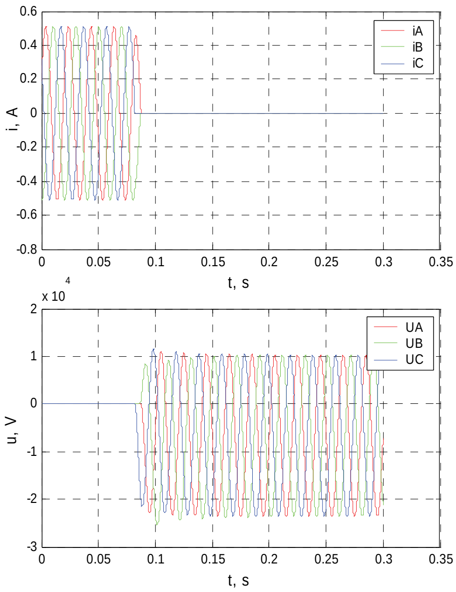

Fig. 5. Phase currents and overvoltages between switch gear’s poles in case of disconnection with a switch gear of an air power line without a load,length 5 km (φ=0°)

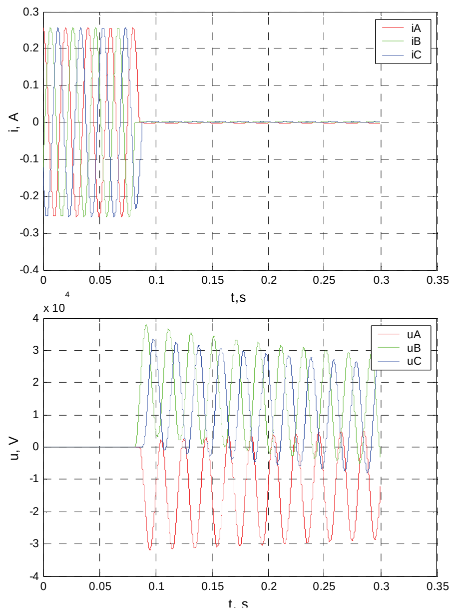

Fig. 6. Phase currents and overvoltages between switch gear’s poles in case of disconnection with a switch gear of an air power line without a load, length 5 km (φ=0°). Power transformer is switched off in a medium voltage sides.

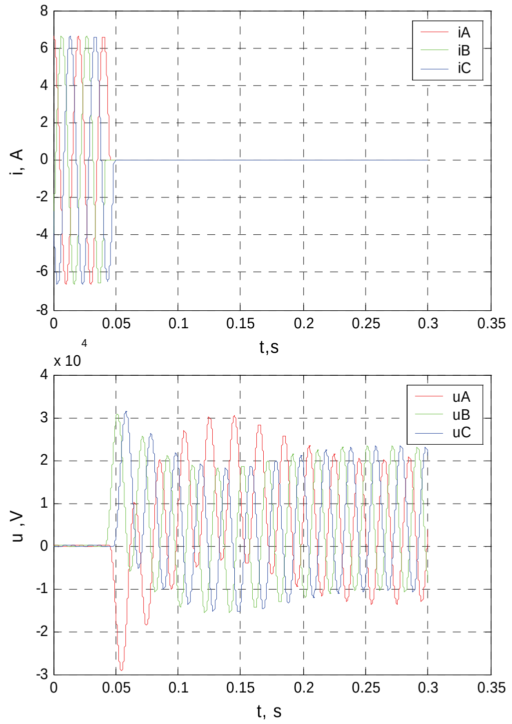

Fig. 7. Phase currents and overvoltages between switch gear's poles in case of disconnection with a switch gear of a cable power line without a load, length 5 km (φ=0°)

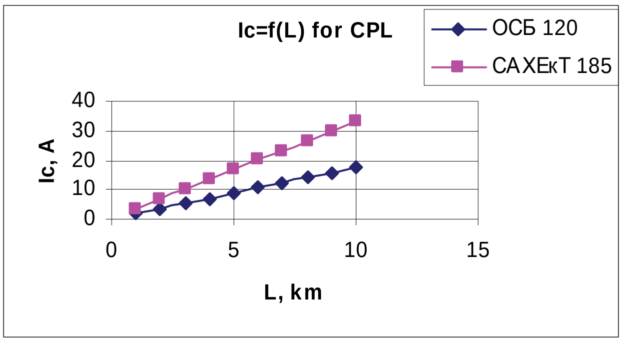

Fig. 8. Dependence between a capacitance current and a length of an air power line

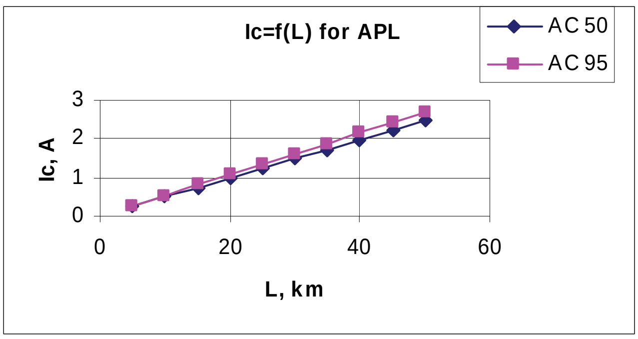

Fig. 9. Dependence between a capacitance current and a length of a cable power line

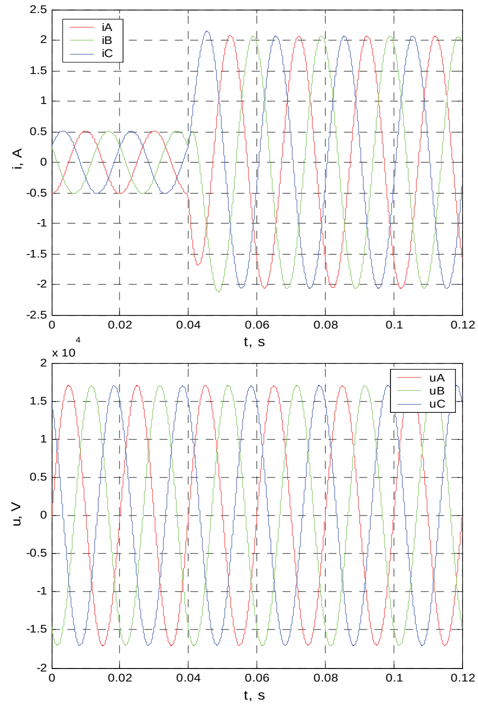

Fig. 10. Phase currents and overvoltages between switch gear's poles in case of connection whit a switch gear of a power line without a load on a power supply in both sides. Voltage dephasing is 0°.

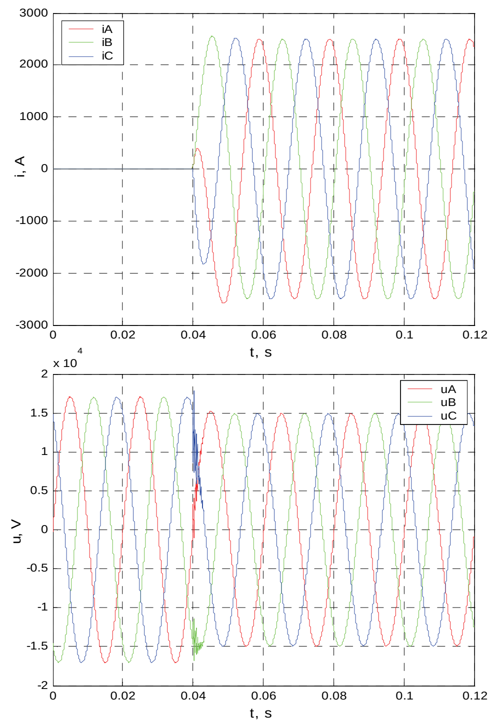

Fig. 11. Phase currents and overvoltages between switch gear's poles in case of connection whit a switch gear of a power line without a load on a power supply in both sides. Voltage dephasing is 120°.

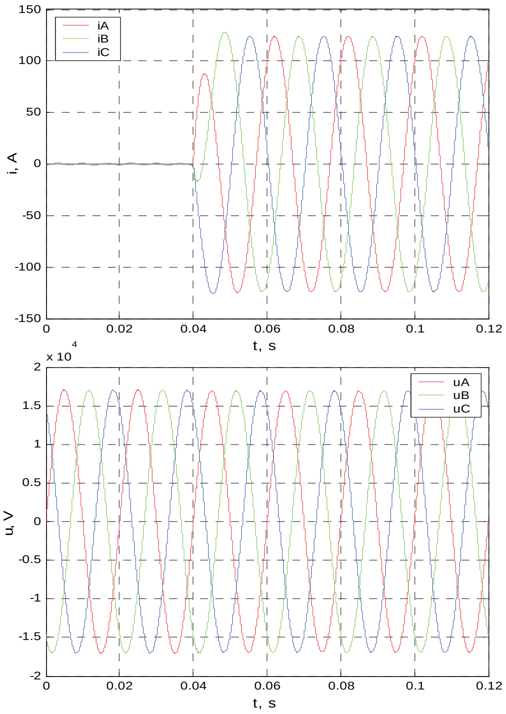

Fig. 12 Phase currents and overvoltages between switch gear’s poles in case of connection whit a switch gear of an air power line on a power supply in both sides. Voltage dephasing is 5°.

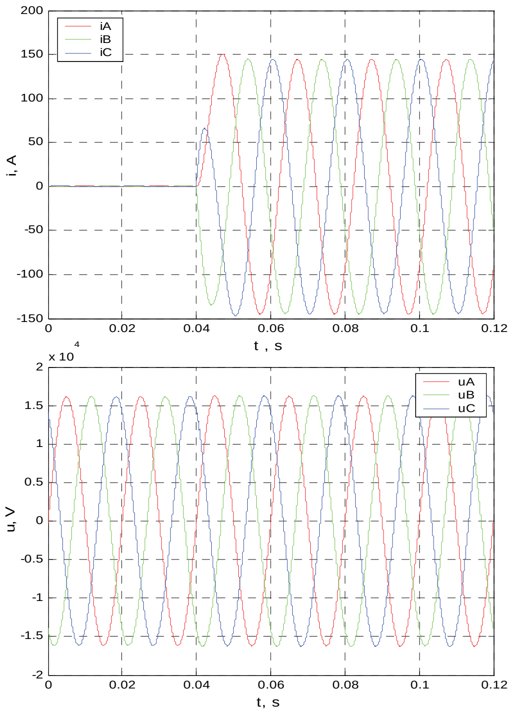

Fig. 13. Phase currents and overvoltages between switch gear’s poles in case of connection whit a switch gear of an air power line on a power supply in both sides. The power transformer’s voltages are 19 kV and 21 kV.

IV. Conclusion

- The maximum values of the overvoltages between the switch gear’s poles are changed in an interval 1,28 – 1,94 p.u. ($1\,p.u. = \frac{\sqrt{2}.U_m}{\sqrt{3}}$; U_m=24 kV). This overvoltages are not dangerous for the switch gear’s air insulation and will not lead to the repeated discharges.
- There aren’t a surface discharge on the supporting insulator.
- Overvoltages between the switch gear’s poles are dangerous for the cable insulation, particularly when the insulation has decreased electrical strength.
- The values of the current flowing through the switch gear of the air power line’s part are lower in comparison with the cable part (Fig. 4).
- The operation of the switch gears depends on the length of the power line. It influence is bigger in the cable power lines due to higher capacitive current.
- The higher values of the overvoltages are received at the switching off of the power lines without loads and switched off supply transformers at the medium voltage side. (Fig. 6).
- The currents through the switch gear and overvoltages are not danger (Fig. 10) under switching on of the supplied from the booth sides line at the phased voltages even at differing amplitudes, but the currents values are similar as the short circuit current when there are dephased voltages (Fig. 11).
- The current through the switch gear doesn’t have high values (up to 6 A at the length of cable power line to 5 km) without loads.

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