Modeling the electrical behavior of the TKJ on EMTP-RV

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Plan

1 – Definition

2 – Modeling method on EMTP-RV

3 – Dynamic Link Library and EMTP-RV

4 – Dynamic Link Library and TKJ

5 – Validation of the model

6 – Conclusion
1 – Definition
1–Definition

TKJ :  

Multiphase, inversed, rectified synchronous machine
2 - Modeling method on EMTP-RV
2 - Modeling method on EMTP-RV

TKJ on EMTP
The electromagnetic field in the winding “j” of the machine is given by this equation:

\[ e_j(t) = -R_s i_j(t) - \frac{d\psi_j(t)}{dt} \]

\[ V_f(t) = R_f i_f(t) + \frac{d\psi_f(t)}{dt} \]

Where:

\[ \psi_j(t) = M_{fj}(t) i_f(t) + \sum_{k=1}^{q} M_{jk}(t) i_k(t) \]

\[ \psi_f(t) = M_{ff} i_f(t) + \sum_{k=1}^{q} M_{fk}(t) i_k(t) \]
3 – Dynamic Link Library and EMTP-RV
What is the DLL?

- allow EMTP-RV users to develop advanced program model modules and interface them directly with the EMTP-RV engine.

How can the DLL interact with the engine of EMTP-RV?

- by allowing the DLL function to access the main system of equations in the same way as the developer of EMTP-RV.
The main system of equations in EMTP-RV is given by:

\[
\begin{pmatrix}
Y_n & V_c \\
V_r & V_d
\end{pmatrix}
\begin{pmatrix}
V_n \\
i_V
\end{pmatrix}
=
\begin{pmatrix}
i_n \\
V_b
\end{pmatrix}
\]

Where:

- \(Y_n\): nodal admittance matrix
- \(V_c, V_r, V_d\): used to include non-nodal type equations (voltage-defined equations)
- \(V_n\): vector of unknown voltages
- \(i_V\): vector of unknown currents
- \(i_n\): nodal current injections
- \(V_b\): for determined quantities related to voltage-defined equations
4 – Dynamic Link Library and TKJ
The electromagnetic field equation:

\[ e_j(t) = -R_s i_j(t) - \frac{d\psi_j(t)}{dt} \]

\[ V_f(t) = R_f i_f(t) + \frac{d\psi_f(t)}{dt} \]

Two integration methods on EMTP-RV:

- trapezoidal;
- Backward-Euler.
Norton equivalent model of the TKJ:

\[ \mathbf{E}(t) + \mathbf{R}_{th}(t) \cdot \mathbf{I}(t) = \mathbf{V}_{th}(t) \]

In this case, the main objective of the DLL is to make these changes to the main system of equations in EMTP-RV:

\[
\begin{pmatrix}
\mathbf{Y}_n(t) & \mathbf{B}_l \\
\mathbf{B} & \mathbf{R}_{th}(t)
\end{pmatrix}
\begin{pmatrix}
\mathbf{V}_{1,..,2,q+2}(t) \\
\mathbf{I}(t)
\end{pmatrix}
= \begin{pmatrix}
\ldots \\
\mathbf{V}_{th}(t)
\end{pmatrix}
\]

- 45 lines and 45 columns are added to represent the machine.
Section 5 – Validation of the model
5 – Validation of the model

Validation by comparing the results with:

- The theoretical curve of the machine
- Another program named ESACAP.

In different cases:

- Load
- open circuit
- short circuit
5 – Validation of the model

Regime en charge R

Regime à vide

Regime en court circuit
6 – Conclusion and perspective
Conclusion :

• DLL -> New models
• Precise model, more efficient than the models presented by the stability-studies.

Perspectives :

• Model the mechanical behavior of the machine ;
• Model the thermal behavior of diodes
Questions ?!
Thank you for your attention!