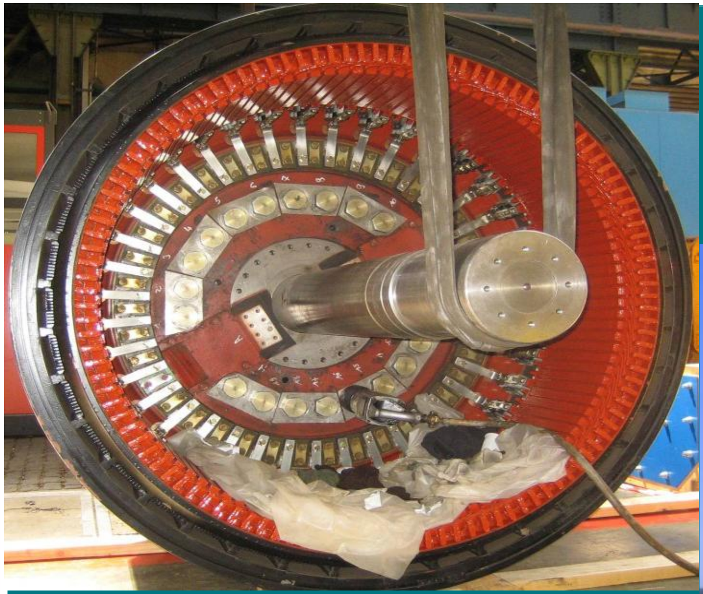

Modeling the electrical behavior of the TKJ on EMTP-RV

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Plan

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1 – Definition

2 – Modeling method on EMTP-RV

3 – Dynamic Link Library and EMTP-RV

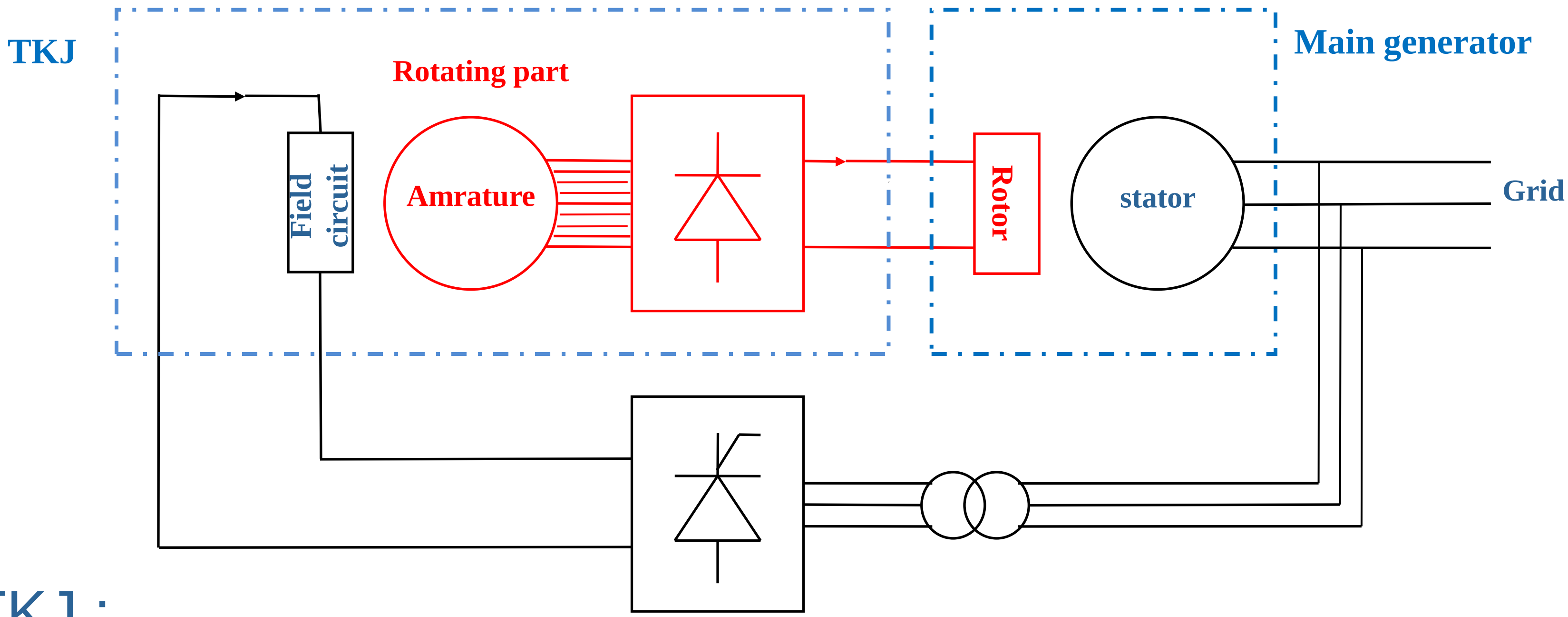
4 – Dynamic Link Library and TKJ

5 – Validation of the model

6 – Conclusion

1 –Definition

1–Definition



TKJ :

Multiphase, inversed, rectified synchronous machine

2 - Modeling method on EMTP-RV

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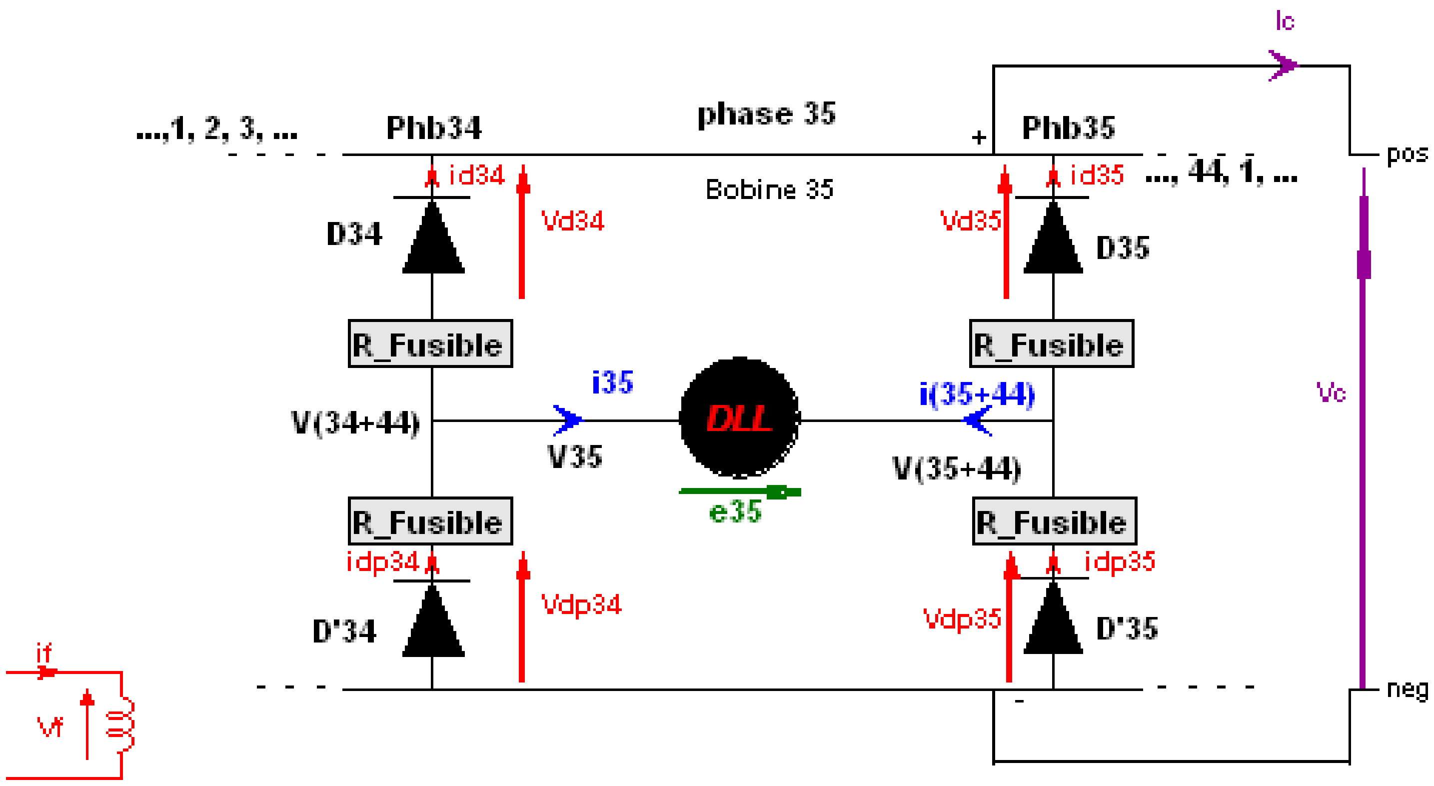
TKJ on EMTP



2 - Modeling method on EMTP-RV

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

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.**

3 – Dynamic Link Library and EMTP-RV

The main system of equations in EMTP-RV is given by:

$$\begin{pmatrix} \mathbf{Y}_n & \mathbf{V}_c \\ \mathbf{V}_r & \mathbf{V}_d \end{pmatrix} \begin{pmatrix} \mathbf{V}_n \\ \mathbf{i}_V \end{pmatrix} = \begin{pmatrix} \mathbf{i}_n \\ \mathbf{V}_b \end{pmatrix}$$

Where :

Yn : nodal admittance matrix

Vc, Vr and Vd : used to include non-nodal type equations (voltage-defined equations)

Vn : vector of unknown voltages

iV : vector of unknown currents

In : nodal current injections

Vb : for determined quantities related to voltage-defined equations

4 – Dynamic Link Library and TKJ

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:

- **trapezoïdal ;**
- **Backward-Euler.**

4 – Dynamic Link Library and TKJ

Norton equivalent model of the TKJ :

$$\mathbf{E}(t) + \mathbf{R_{th}}(t).\mathbf{I}(t) = \mathbf{V_{th}}(t)$$

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

$$\left(\begin{array}{c|c} \mathbf{Y}_n(t) & \mathbf{B}_I \\ \hline \mathbf{B} & \mathbf{R}_{th}(t) \end{array}\right) \cdot \left(\begin{array}{c} \mathbf{V}_{1,\dots,2.q+2}(t) \\ \hline \mathbf{I}(t) \end{array}\right) = \left(\begin{array}{c} \dots \\ \hline \mathbf{V}_{th}(t) \end{array}\right)$$

- **45 lines and 45 columns are added to represent the machine**

5 – Validation of the model

5 – Validation of the model

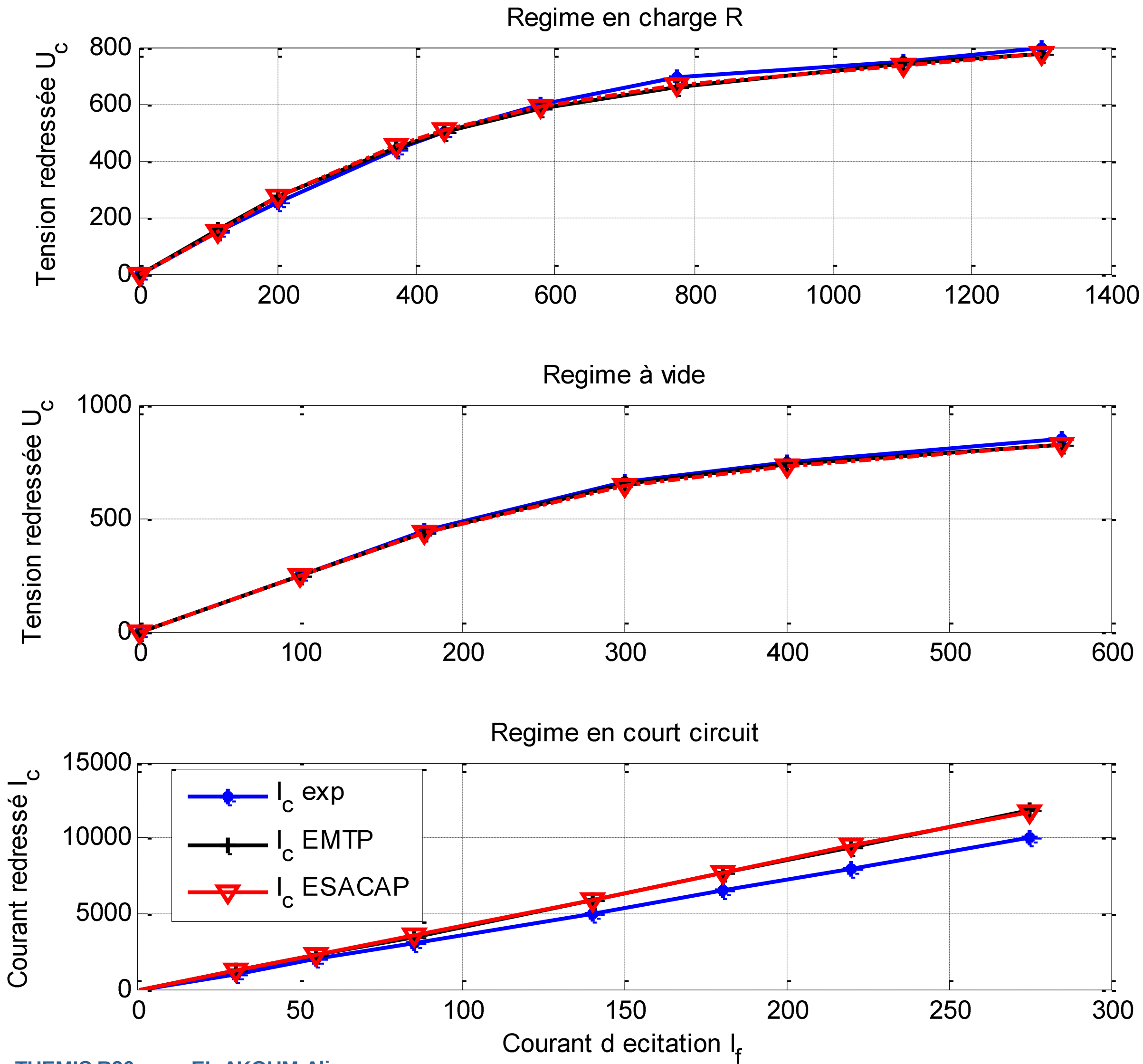
Validation by comparing the results with :

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

In different cases:

- **Load**
- **open circuit**
- **short circuit**

5 – Validation of the model



6 – Conclusion and perspective

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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!